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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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OFFICIAL ORGAN OF THE
Illuminating Engineering Society.
(Founded in London 1909.)

Special Factory Lighting Number.

This number contains an abstract (pp. 369-390) of the recently issued *First Report* of the *Departmental Committee* on *Lighting in Factories and Workshops.*

Other matters dealt with include :—

STREET LIGHTING IN CHICAGO—LIGHT AND SUPERSTITION—THE FIREFLY AND OTHER LUMINOUS ORGANISMS—HIGH PRESSURE GAS LIGHTING IN AN ENGINEERING WORKSHOP—A NEW TYPE OF ILLUMINATED SIGN—A PORTABLE ACETYLENE LAMP, &C.

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EDITORIAL.

The First Report of the Departmental Committee on the Lighting of Factories and Workshops.

An important section of this issue is occupied by the abstract of the above Report (pp. 371-390), the publication of which has been awaited with great interest. It makes an opportune appearance at the present moment. The workshops of the nation are very fully occupied. Many firms are working overtime on Government contracts and are making every effort to turn out their goods as speedily and efficiently as possible, and we are also approaching the period of the year when arrangements must be made for artificial lighting in the dark winter months to come.

Before commenting on the contents of the Report we should like to pass in review a few of the events of the past seven years leading up to the formation of the Committee. Industrial illumination has been much discussed on the platform of the Illuminating Engineering Society, and at various international congresses, and the wide notice given to these proceedings in the press has done a great deal to pave the way for scientific inquiry. In view of the millions of people engaged in the industries of this country, and the vast revenue derived from our export trade, the importance

of any measures likely to increase production and to promote the comfort and convenience of operators is evident.

The very first issue of the ILLUMINATING ENGINEER, in January, 1908, contained several articles on factory lighting. During this year there was appointed the Departmental Committee on Accidents in Factories and Workshops, a Committee whose work formed a useful preliminary to the appointment of the present researches on factory lighting.

In 1909 an important Report was issued by MM. Chantemesse and Walckener under the auspices of the Conseil d'Hygiene de la Seine.[1] This contained a useful summary of the legislation of various countries bearing on industrial illumination, and may be regarded as the first attempts to deal broadly with the subject of industrial illumination. In the same year requirements in regard to adequate lighting in connection with certain trades (lead working, vitreous enamelling, &c., and underground bakeries) were introduced, and an account of these was contributed to the ILLUMINATING ENGINEER by H.M. Chief Medical Inspector of Factories, Dr. T. M. Legge.[2]

In 1910 an important congress took place in Brussels, the Congrès International des Maladies Professionelles,[3] at which the writer was present as a delegate of the Illuminating Engineering Society and presented a paper on the Hygienic Aspects of Illumination. Industrial illumination received special notice at this Congress, special emphasis being placed on the need for adequate illumination in places where danger was apprehended. This point again received recognition in the Report of H.M. Chief Inspector of Factories, issued in this year (1910), in which the absence of any legislation on factory lighting was remarked on and the importance of good illumination pointed out "as a matter of safety (especially where dangerous processes are carried on); as bearing upon the health in many ways, directly and indirectly; and as a condition of efficient work."

Reference was also made to the exceptional importance of lighting in regard to underground premises.[4]

In 1911 the Report of the Departmental Committee appointed to inquire into Accidents in Factories and Workshops appeared. It contained a recommendation that "general statutory powers to require adequate lighting" should be conferred on the Home Office.[5] A most important event during this year was undoubtedly the appointment by the Minister of the Interior in France of a State Committee on Illumination, charged with functions similar to those of the Committee in this country which has just reported.[6] Yet another important step was the resolution to form an International Commission on Illumination, passed at the International Congress of Applied Electricity at Turin (September, 1911).[7]

In 1912 the Report of H.M. Chief Inspector of Factories again contained many references to lighting, including a special report by Mr. D. R. Wilson[8] on Illumination. A report issued about this time by the National Association of Manufacturers in the United States,[9] contained the result of inquiries among a large number of manufacturers with respect to the benefit derived from improved conditions of lighting. Subsequently another opportunity of bringing forward the claims of good industrial illumination was afforded

[1] *Illum. Eng.*, Vol. II., 1909, pp. 229, 319.
[2] *Illum. Eng.*, Vol. II., 1909, p. 373.
[3] *Illum. Eng.*, Vol. III., 1910, p. 599.
[4] *Illum. Eng.*, Vol. III,. 1910, p. 493.
[5] *Illum. Eng.*, Vol. IV., 1911, p. 401.
[6] *Illum. Eng.*, Vol. IV., 1911, p. 455.
[7] *Illum. Eng.*, Vol. IV., 1911, p. 616.
[8] *Illum. Eng.*, Vol. V., 1912, pp. 380, 418.
[9] *Illum. Eng.*, Vol. V., 1912, p. 384.

by the First International Congress for the Prevention of Industrial Accidents, held in Milan in May, 1912,[10] at which the Home Office was officially represented and the writer again took part as a delegate of the Illuminating Engineering Society. At this Congree the connection between accidents and insufficient lighting was much discussed, and various aspects of industrial illumination were dealt with by a number of delegates from various countries. This Congres was the means of bringing the subject before the notice of the Governments of all the chief nations and shortly afterwards the Académie Royale de Médecine de Belgique approached the Belgian Government with a view to the appointment of a similar committee to that established in France.[11]

On May 16th several questions were asked in the House of Commons by Dr. Arthur Lynch, M.P., drawing attention to the Committee formed by the French Government[12] and urging the desirability of arranging for an official inquiry into industrial illumination, and elicited the gratifying information from the Home Secretary that an expert Departmental Committee on this subject was to be appointed.

In 1913 the New York State Factory Commission were engaged on a Bill requiring "adequate and proper" lighting of factories,[13] and at the National Gas Congress Exhibition held at Shepherd's Bush in the autumn a special section was given up to industrial illumination, and a variety of papers read emphasising the benefit of good illumination with a view to increased output and better quality of work. The Reports of H.M. Chief Inspector of Factories for this and the following year again contained much useful information on factory lighting, including a special report on the lighting of foundries. Early in the year 1913 came the announcement of the appointment by the Home Secretary of the Departmental Committee on Industrial Illumination.[14]

It will be seen, therefore, that the appointment of this Committee was not a sudden step, but a natural development as a result of several years of persistent propaganda of the illuminating engineering movements.

An examination of the contents of the Report reveals the same care and forethought. The Committee has taken pains to collect all the available information on industrial lighting and the compilation of data on the legislation of other countries will be studied with keen interest by those concerned in the management of factories. Fifty witnesses, including representatives of Trade Association, Factory Inspectors, Medical Officers and Physiologists, Lighting Experts, &c., have been examined. The importance of the subject and the need for investigations are now fully recognised, and to many people it will be a revelation to find how far the scientific study of lighting and illumination measurements have proceeded.

Besides taking evidence the Committee have visited a large number of factories, and about 4,000 measurements in 167 different workrooms have been made. Experiments on specific points were also conducted at the National Physical Laboratory.

This series of measurements was naturally of great value to the Committee in enabling them to judge as to the conditions actually existing in factories and the order of illumination which can conveniently be obtained.

The Committee draws a distinction between the illumination required for convenience and as a measure of safety, and the special illumination

[10] *Illum. Eng.*, Vol. V., 1912, p. 335.
[11] *Illum. Eng.*, Vol. VI., 1913, p. 17.
[12] *Illum. Eng.*, Vol. VI., 1913, p. 16.
[13] *Illum. Eng.*, Vol. V., 1912, p. 284.
[14] *Illum. Eng.*, Vol. VI., 1913, p. 107.

required for certain industrial processes. It would obviously require a very long and careful investigation to decide this last point and it has therefore been reserved for future study. Meantime the figures given in the Report for the illumination at the point of work in those industries so far examined will be found of great interest by those concerned with factory lighting.

As a result of their investigations the Committee suggest that there should be a general requirement of adequate lighting in the Factory Act and they also recommend certain minimum values for the general illumination, which are necessary in the interests of safety and general convenience. In this connection the utility of the complete series of measurements summarised in the Report is very evident. A study of the " frequency of occurrence " curve makes it clear that the values suggested are well below what may reasonably be expected in a modern well-lighted factory. There should, therefore, be no hardship in these recommendations, and their general effect would merely be to bring into line with modern practice those factories which are poorly lighted by antiquated and imperfect methods. The moderation of the proposals will, we feel sure, commend them to the manufacturers. Both among employers and employees there is a widespread recognition, that defective lighting, besides being a possible source of injury to health and a cause of accidents, also tends to restriction of output and spoilage of work. It handicaps the operator in carrying on his daily task and adds to the strain of occupation, especially when he is engaged on highly-skilled and delicate operations. Managers of factories, it will be found, are only too anxious to receive guidance in these matters and we feel sure that they will find in the Report many serviceable and practical suggestions.

We would like to draw attention to the very practical way in which the Report is drawn up. The attempt has been made to express technical matters in a simple and intelligible form. In the past there has been some vagueness as to what was meant by " inadequate " lighting, and the careful explanation of the various defects which are included in this expression will help to make this matter clear. An enterprising step is the issue of a popular abstract in the form of a memorandum accompanying the Report, explaining the general objects which the Committee have in view.[15] It is hoped that this will be of considerable assistance to the press and to the general public.

This Report marks a new departure in the study of factory lighting. It is a piece of work quite different from anything published in other countries, and in this particular matter we may claim to have taken a step in advance of the rest of the world. The effect of the Report should be to place industrial illumination in this country on a higher plane and to strengthen the position of those in other countries who are working for the same ends.

At the present time the public mind is awakening to the value of science. We venture to think that we have here an excellent example of the modern application of science to practical affairs. The lighting industry is under a debt of gratitude to the Members and the Secretaries of this Committee, and the Report should be generally received as a most useful and timely production of which we have every reason to be proud.

LEON GASTER.

[15] An abstract of this Memorandum will be found in the following two pages

MEMORANDUM ON THE FIRST REPORT OF THE DEPARTMENTAL COMMITTEE ON LIGHTING IN FACTORIES AND WORKSHOPS.

(Slightly abbreviated).

THE development of industrial operations and the introduction of many new methods of illumination during the last 10 years have served to emphasise the need for statutory requirements relating to the lighting of workshops and factories, similar to those which already exist in regard to heating and ventilation.

The present Committee was appointed—

> "to enquire and report as to the conditions necessary for the adequate and suitable lighting (natural and artificial) of factories and workshops, having regard to the nature of the work carried on, the protection of the eyesight of the persons employed, and the various forms of illumination."

EXISTING LEGISLATION.

For the United Kingdom no general provisions in regard to lighting (analogous to those regarding heating and ventilation) occur in the Factory Acts, although adequate lighting in general terms is included among the conditions to be satisfied in underground bakehouses, and is required in certain dangerous trades.

On the other hand, the codes of all the chief European countries, the United States, and India contain provisions requiring adequate lighting in factories.

NATURE OF ENQUIRY.

The appointment of the Committee in regard to Industrial Lighting thus marks an entirely new departure in this country.

In view of the wide ground covered by the terms of reference it was considered advisable to limit the enquiry in the first instance as far as possible to the engineering, textile, and clothing trades. Evidence was received from 50 witnesses, including H.M. Inspectors of Factories and representatives of various trade associations and scientific and technical societies.

The members of the Committee also paid a series of visits to various industrial centres, 85 works being visited. In connection with these visits about 4,000 measurements of illumination were made in 163 rooms in 57 factories.

Certain experiments bearing on the standards of illumination required for various purposes were also carried out at the National Physical Laboratory.

EFFECTS OF BAD LIGHTING.

The enquiry showed that there has been a great advance in methods of illumination, but various defects were met with, and the Committee endeavoured to obtain particulars of the effect of unsatisfactory lighting.

A statistical enquiry into the number of accidents during each month throughout the year points to the conclusion that inadequate lighting is a contributory cause of accidents. This is confirmed by the evidence of witnesses, and by the statements of the Accident Offices' Association.

Complaints of eye strain, headache, &c., attributed to insufficient lighting are common, and while an exhaustive medical enquiry would be necessary to establish the connection between these defects and inadequate lighting, there is a general impression that unsatisfactory lighting is, in various ways, prejudicial to health. It is also recognised that insufficient light adds to the difficulty of the proper supervision of work, and of the maintenance of cleanliness and sanitary conditions generally.

Witnesses gave specific instances of the effect of improved lighting in increasing the output and improving the quality of work turned out.

RECOMMENDATIONS.

From the evidence taken it is apparent that there is a general consensus of opinion as to the economic and hygienic advantages of adequate and suitable lighting. That this opinion is based on experience is shown by the great improvement in lighting which has taken place during recent years, and is still continuing, and in modern factories good lighting is now regarded as one of the most important factors contributing to industrial efficiency. On the other hand many employers have lagged behind in the general advance. This refers especially to old factories, and it is obvious that any requirement which would tend to bring such places up to the level of more progressive firms would be beneficial, not only to the operative by improving his working conditions, but also to the employer himself by increasing his output and by improving the quality of work. Light is a cheap commodity and little or no hardship should result from such a requirement, if gradually and sympathetically enforced.

The Committee therefore recommend that there should be a statutory provision :—

(*a*) Requiring adequate and suitable lighting in general terms in every part of a factory or workshop, and (*b*) Giving power to the Secretary of State to make Orders defining adequate and suitable illumination for factories and workshops or for any parts thereof or for any processes carried on therein.

It is further necessary to define more precisely the term "adequate lighting." In order to justify this description, the illumination should comply with the following requirements :—

(*a*) Adequacy. (*b*) A reasonable degree of constancy and uniformity of illumination over the necessary area of work. (*c*) The placing or shading of lamps so that the light from them does not fall directly in the eyes of an operator when engaged on his work, or when looking horizontally across the workroom. (*d*) The placing of lights so as to avoid the casting of extraneous shadows on the work.

The next question is the desirability of specifying the amount of illumination implied in the terms "adequate and suitable." Owing to the great progress that has recently been made in the appliances for measuring illumination (the nature of which is explained in the Report), it is now practicable to specify numerical values in a manner that would hardly have been possible some years ago.

The Committee propose the following minimum values of illumination (measured at floor level) as being desirable from the standpoint of general convenience and safety :—

	Ft.-candle.
In the working areas of factories generally	0·25
the working areas of foundries	0·4
all parts of factories, over which people are liable to pass ..	0·1
open places where people are employed, dangerous parts of regular roads and approaches	0·05

Provision is also made for exemption in individual cases; ship building yards are to receive separate consideration.

These values are suggested without prejudice to the special illumination required for the carrying out of the work, which naturally varies greatly according to the nature of the operations. At present the Committee are not prepared to recommend standards of illumination for these purposes, which require further investigation.

In conclusion the Committee point out that the minimum values prescribed are considerably lower than those proposed by many witnesses and are also lower than those found to exist in the majority of factories visited. In many cases manufacturers would naturally prefer to provide a substantially higher value than that indicated. The intention has been to propose values which can be adopted as a practical legal minimum without causing hardship, and would serve the purpose of raising the level of illumination in those factories which are behind modern practice in this respect.

Adequate artificial lighting is an important matter in the utilisation of factories for night work. The information contained in the report should therefore be of special interest at the present moment, when many factories are working overtime, and preparations are being made for the period of the year when artificial lighting is mainly required.

ABSTRACT OF THE FIRST REPORT OF THE DEPARTMENTAL COMMITTEE ON LIGHTING IN FACTORIES AND WORKSHOPS.*

Constitution and Terms of Reference.

THE Committee was appointed by the Home Secretary in 1913, and originally consisted of the following:—

Dr. R. T. Glazebrook, C.B., D.Sc., F.R.S., Director of the National Physical Laboratory.
Mr. L. Gaster.
Prof. Francis Gotch, D.Sc., F.R.S.
Mr. J. Herbert Parsons, M.B., D.Sc., F.R.S.
Mr. W. C. D. Whetham, F.R.S.
Sir Arthur Whitelegge, K.C.B., Chief Inspector of Factories.

Dr. Glazebrook was appointed Chairman of the Committee and Mr. D. R. Wilson, one of H.M. Inspectors of Factories, and Mr. C. C. Paterson, of the National Physical Laboratory, were appointed to be Secretaries of the Committee. Owing to the death of Professor Francis Gotch at an early stage of the proceedings, Professor C. S. Sherrington was appointed to fill the vacancy on May 29th.

The terms of reference of the Committee are stated as follows:—"To enquire and report as to the conditions necessary for the adequate and suitable lighting (natural and artificial) of factories and workshops, having regard to the nature of the work carried on, the protection of the eyesight of the persons employed, and the various forms of illumination."

Methods of Investigation.

The methods of investigation may be divided roughly into two sections—Evidence of Witnesses and Experimental Work. In the course of the enquiry the Committee has held 38 meetings and received evidence from about 50 witnesses. The latter include:—Official representatives (Inspectors of Factories, Medical Officers of Health, Factory Certifying Surgeons, etc.); Professional, Technical and Scientific Witnesses (Lighting Experts, Representatives of Professional and Scientific Societies, Architects, Surveyors, and Medical Experts); Representatives of Trade Associations (both Employers and Operatives).

Witnesses were nominated by the following societies:—

The Illuminating Engineering Society,
The Institution of Electrical Engineers,
The Institution of Gas Engineers,
The Ophthalmological Society of the United Kingdom,
The Royal Society of Medicine,
The Royal College of Surgeons,
The Royal Institute of British Architects,
The Surveyors' Institution.

At the outset of the enquiry it was decided to obtain practical data regarding the natural and artificial lighting of factories at the present time. In view of the wide ground covered by the terms of reference it was, however, decided to limit the enquiry to the textile, engineering, and clothing trades, certain general considerations applicable to all trades being taken into consideration. As a

* Blue Book (Cd. 8000), Vol. I. Report and Appendices, Vol. II. Evidence. Issued by His Majesty's Stationery Office by Eyre & Spottiswoode, Ltd., East Harding Street, E.C. To be purchased either directly or through any bookseller, from Messrs. Wyman & Sons, Ltd. (London and Cardiff), H.M. Stationery Office (Edinburgh), E. Ponsonby, Ltd. (Dublin), or from the Agencies in the British Colonies and Dependencies, the United States of America and other foreign countries, of T. Fisher Unwin (London, W.C.).

rule, measurements were made previous to the visits of the Committee so that definite facts should be available at the time the illumination of the factory was inspected.

In the course of the investigation about 4,000 measurements in 163 rooms of 57 representative factories and workshops were made by Mr. J. W. T. Walsh of the National Physical Laboratory and Mr. G. F. Sedgwick, H.M. Inspector's Assistant. All these data are published in an Appendix to the Report, together with particulars as to the size of rooms and windows, and the number and nature of the light sources installed.

In addition to the above experimental work, a number of special observations were carried out at the National Physical Laboratory, a room being prepared in which the conditions of illumination could be changed at will. These observations included tests of workpeople using various materials, the object being to ascertain the intensity of illumination preferred for various processes, and the effect of altering the colour of the material used in the clothing industry.

Explanation of Technical Terms.

The Report next passes on to explain various terms used in referring to illumination.* After defining the "foot-candle" the Report points out how the quantity of light reflected from a surface depends on its colour and why, therefore, dark materials in general require a higher illumination than those which are light in hue.

In connection with glare a distinction is drawn between the effect of bright sources in the direct line of sight and those seen obliquely "out of the tail of the eye." Attention is also drawn to the glare experienced when light is reflected directly into the eyes from objects having a highly polished surface.

A brief reference is also made to the "daylight factor" (*i.e.*, the relation between the natural illumination at a point inside a room and the total unrestricted illumination out of doors). This quantity should be approximately constant for a given interior and depends chiefly on the window-area which is effective in admitting daylight to the point in question. The term is fully explained in an Appendix.

Existing Requirements as to Lighting.

For the United Kingdom no general provisions in respect to lighting (analogous to those regarding temperature and ventilation) occur in the Factory Acts. The only reference to the subject is found in the Factory Act of 1901, Section (4), which specifies adequate lighting amongst the conditions as to which a local authority must be satisfied before an underground bakehouse is certified as suitable for use.

Under Section 79 of the Act of 1901 the Secretary of State has power to make regulations for certain trades certified by him to be dangerous. These regulations, after conforming to a certain procedure, eventually attain the force of statutory enactments. Some 20 codes of regulations exist, and of those five (relating to Docks, use of Locomotives, etc., on premises under the Factory Acts, Vitreous Enamelling of Metal and Glass, Generation of Electrical Energy and Manufacture and Decoration of Pottery), contain provisions requiring adequate lighting in general terms for certain processes. Finally, adequate lighting is required in two Special Orders made by the Secretary of State relating to Fruit Preserving and Sanitary Accommodation.

In order to obtain information as to the position in foreign countries, inquiry was made through the Foreign Office as to the requirements in force in Austria, Belgium, Denmark, France, Germany, Holland, Italy, Norway, Sweden and the United States of America. The replies received are summarised in an Appendix. Adequate lighting in general terms is required in the codes of all the European countries mentioned, and in those of most of the United States, either by legislation or statutory regulations. For local lighting in certain trades definite standards are prescribed in Holland only, whilst a provision against excessive glare is found in the Belgian code.

* In view of the novel nature of the subject this is a wise step and should help to make the Report readily intelligible to those manufacturers as are not very familiar with such expressions as "intensity of illumination" and "surface brightness."

A provision requiring giving the Inspector power to require adequate lighting in factories exists in the Indian Factory Act for 1911. It also appears that a definite standard for the general lighting of factories is now in force in New South Wales.

Reference is also made in the Report to the London Building Act of 1894 and the building regulations of many provincial authorities, limiting the amount of wall space in laterally lighted rooms to one-half the total wall space. According to some witnesses this unnecessarily interferes with the lighting of the building. Similarly, the regulations prescribing whitewashing of roof windows of cotton cloth factories during the summer months demand careful consideration in relation to certain classes of work with dark materials, for which all available illumination is needed on dark days.

There are also regulations issued by the Board of Education with regard to school buildings, requiring adequate window space, suitably-placed windows, light walls, etc., and there are similar regulations in force in most of the foreign countries of which enquiry has been made. The construction of workhouses and other buildings under the control of the Local Government Board is subject to special instructions issued by the Board. Finally the Housing, Town Planning, etc., Act of 1909 empowers local authorities to make regulations for underground rooms habitually used as sleeping places.

Present Conditions of Lighting in Factories.

Natural Lighting.

The natural lighting of buildings may be derived either from the roof (roof or top lighting) or from side windows (lateral lighting) or from both combined.

Roof lighting is obviously only available in single storied buildings or in the top floor of a block. A common arrangement in weaving sheds is the "saw-tooth" type of roof. With a good system of roof lighting the illumination is very uniform and may attain from 2 to 10 per cent. of the outside unobstructed illumination. The large extent of surface sometimes makes it difficult to maintain an equable temperature; whitewashing the glass to keep out the direct rays of the sun is largely practised in summer, while extra means of heating are provided during the winter.

In most trades, where the working plane is horizontal, lateral lighting is inferior to roof lighting. In modern factories dependent mainly on lateral lighting a large part of the wall surface (sometimes as much as 60 per cent.) may be occupied by windows but even so there is a limit to the depth of room—beyond which the illumination falls below what is considered an adequate value. The illumination near the windows may be well lighted, while the most remote parts of the room may require permanent artificial illumination.

Artificial Lighting.

The conditions of artificial lighting vary so widely that only a very general statement can be made. The Committee express the view that the artificial lighting of factories has made great strides during recent years. Generally speaking, in modern factories good illumination is provided where it is required for the actual purposes of manufacture, though complaints have been received of inadequate lighting in some trades where fine work (tailoring, sewing, lace making, &c.) is carried on. Insufficient illumination is more commonly met with in the general lighting of premises, or in the lighting of gangways, stairways, &c.; in this respect the conditions in many factories are capable of much improvement. Instances of glare and inconvenient shadows are also mentioned.

Causes of Unsatisfactory Illumination.

Natural Lighting.

Among the causes of unsatisfactory natural lighting the Committee mention:

(1) Old and unsuitable buildings.
(2) Obstruction of light.
(3) Dirty windows.
(4) Dirty walls and ceilings.

There is a great contrast between the conditions of illumination in old converted buildings, originally intended for dwelling houses, &c., and those met with in modern factories, which are usually excellently lighted. Underground workrooms are frequently poorly lighted and

in some instances require the continuous use of artificial illumination. At present there appears to be no legislation with regard to the use of such premises for industrial purposes except in the case of underground bakeries (referred to on p. 372.)

Obstruction is usually caused by adjacent buildings, and may be mitigated by whitewashing the obstructing surface, or the adoption of special mirrors or glass. The temporary storage of materials inside the factory and the presence of high machines also obstruct the light in some instances.

Dirty windows are a frequent cause of insufficient lighting, and periodical cleaning is desirable. Similarly dirty walls and ceiling cause a loss in reflected light. The Committee lay stress on the value of light surroundings as an inexpensive means of improving the illumination and furnishing a useful background to dark objects.

At present there are not available complete statistics showing the effect of habitual use of artificial light and the exclusion of daylight on health. There is, however, a general concensus of opinion among witnesses of all classes that conditions involving the continuous use of artificial light are unnatural and entail a greater strain on the workers.

The Report makes the following suggestions for promoting access of daylight, of which full use should be made in overshadowed rooms :—

(1) The windows should be of adequate size and extend as near the ceiling as possible.

(2) They should be kept clean and free from unnecessary obstruction within.

(3) Vertical light can be deflected into the room by means of reflectors or prismatic glassware.

(4) It may be possible to whiten the surface of an external wall or building which obstructs the light.

(5) The inside walls and ceiling should be white or nearly white.

(6) The positions of the permanent working points should be so adjusted in relation to the windows and to internal obstructions of whatever kind as to secure as far as practicable adequate daylight for each.

It is pointed out that improved daylight facilities, by restricting the period during which artificial light is needed, constitute an economy. The question of a standard for daylight is a difficult one, which is to receive further investigation. Attention is, however, called to the use of the "daylight factor" which may be of service in this direction.

Artificial Lighting.

Among the causes of unsatisfactory illumination are mentioned :—

(1) The provision of too few or too weak lights.
(2) Antiquated Methods of Lighting.
(3) Inadequate supply.
(4) Neglect of Upkeep.
(5) Inside Obstruction.
(6) Shadows and improper placing of lights.

Reference is made to the continued use of flat flame gas burners in some factories where modern methods of incandescent gas lighting might be more fitly used. Complaints have also been received of inadequate illumination caused by diminished pressure from gas mains during the period of maximum supply, and by the installation of a dynamo or engine of insufficient power in cases where electric energy is generated on the premises.

Systematic attention to the lights is desirable to avoid loss of light through accumulation of dust. Obstruction may be caused by travelling cranes and shadows are apt to be thrown on the work if the positions of lamps are not carefully selected—as for example in machine sewing and boot-making.

The Effects of Unsatisfactory Lighting.

Among the effects of artificial lighting may be mentioned :—

(1) Accidents.
(2) Damage to Eyesight and Health.
(3) Insanitary Conditions.
(4) Diminished output of work.
(5) Lack of Discipline.

The connection between lighting and accidents has been studied by means of a special return of the accidents during 1913 and part of 1914. It appears that accidents due to "persons falling" (a cause which would seem to be specially dependent on lighting conditions) are more numerous during the winter months when

artificial lighting is mainly used. The results indicate that for most industries the probable accident rate per hour is far higher for artificial than for natural lighting, in some cases to the extent of 40 per cent. It is pointed out that, strictly speaking, these statistics only allow of a comparison between natural and artificial lighting and not between good and bad lighting of the same kind. But inasmuch as natural lighting may be considered superior to artificial lighting, so far at any rate as regards liability to accident, it may be inferred that the same relationship would hold good between any methods of good and bad lighting.

Further confirmation of the greater risk of accident during the night was given in the evidence of several witnesses. Thus it was pointed out that the number of accidents occurring in shipbuilding yards at night is quite out of all proportion to the small number of men employed. Instances of accidents due to bad lighting conditions were also given for foundries, iron and steel works, lace factories and cotton mills.

An inquiry was also addressed to the Accidents Offices Association, which embraces most of the Insurance Companies interested in the Workmen's Compensation Act. In the reply of the Association it was stated that :—

(A) "The rates of premium charged by its members are based upon the assumption that the lighting is normal; that if, upon survey, this is not found to be so, the insuring Company would specify its requirements or deal with the case by rating."

(B) "The effect of deficient or bad lighting upon a risk is distinctly prejudicial in varying degrees from the accident point of view."

As regards the question of damage to eyesight and health the Committee remark that complaints as to eyestrain and headache attributed to artificial light are common. Numerous references are also made to glare from light sources, and to the prevalence of the use of spectacles among workers in certain trades (drawing in and twisting embroidery, tailoring, &c.). Without an exhaustive medical examination of the eyes of large numbers of workers it is impossible to draw definite conclusions on this point. It is, however, well known that serious injury accrues from exposure to very intense light, such as welding, glass bottle making, &c., and many expressions of opinion have been received to the effect that insufficient light and excess of light, especially when accompanied by glaring sources in the field of vision, are responsible for injury to the eyes.

The absence of sufficient light is detrimental in that dirt is allowed to escape notice, and this aspect is recognised in regard to fruit-preserving and underground bakehouses, in which adequate illumination is required by law.

The effect of improved lighting in improving the quality and increasing the output of work has been noted by many witnesses. In one instance the output was diminished 12—20 per cent. during the period of artificial lighting, and in another the earnings of the workers increased 11.4 per cent. after the installation of a better system of lighting. Confirmatory evidence has been published in the United States of America. Good lighting is also essential for the proper supervision of work and the detection of idling and irregularities.

Recommendations.

From the evidence submitted the Committee find that there is a general consensus of opinion as to the economic and hygienic advantages of adequate and suitable lighting. That this opinion is based on experience is shown by the great improvement in industrial lighting which has taken place in recent years and is still continuing. In the designing of modern factories good lighting (both natural and artificial) is now regarded as one of the most important factors contributing to industrial efficiency. On the other hand many employers have lagged behind the general advance. This applies especially to old factories designed before the importance of illumination was generally recognised, and to small workshops, of which the occupiers perhaps hesitate to expend the capital necessary for improvement.

It is obvious that any requirement which would tend to bring such places up to the level of the more progressive firms would be beneficial, not only to the

operative by improving his working conditions, but also to the employer himself by increasing his output. Light is a cheap commodity and little or no hardship should result from such a requirement, if gradually and sympathetically enforced.

It has been remarked that there is evidence of a relationship between accident risk and adequacy of lighting, and although complaints as to damage to eyesight resulting from bad lighting are general in character, and specific instances of injury are difficult to substantiate, there is evidence of the existence of minor ailments and general impairment of efficiency which must eventually react on the health of the workers.

The Committee also point out that the degree of comfort in the working conditions is doubtless largely determined by the adequacy of the lighting. The visits paid to factories have enabled them to realise the contrast between the depressing effect of dark surroundings and the cheerfulness of a brightly illuminated workroom; and the vast difference in the working lives of the operatives that must result from continual employment under the two conditions.

Finally it is pointed out that the necessity of adequate lighting in factories and workshops has long been recognised abroad, and the industrial codes of all the principal countries contain provisions requiring it in general terms.

The Committee therefore recommend that:—

1. There should be a statutory provision—

(*a*) requiring adequate and suitable lighting in general terms in every part of a factory or workshop, and

(*b*) giving power to the Secretary of the State to make Orders defining adequate and suitable illumination for factories and workshops or for any parts thereof or for any process carried on therein.

It is desirable to define as closely as possible what is meant by "adequate and suitable lighting." The lighting is regarded as adequate and suitable, provided that:—

(*a*) it is sufficient for the proper carrying out of the work both as regards quality and output, and

(*b*) there are no lighting conditions, prejudicial to the health, comfort and safety of the workers.

In order to satisfy these conditions the lighting should comply with the four requirements previously specified, namely:—

(1) Adequacy.

(2) A reasonable degree of constancy and uniformity of illumination over the necessary area of work.

(3) The placing or shading of lamps so that the light from them does not fall directly on the eyes of an operator when engaged on his work, or when looking horizontally across the workroom.

(4) The placing of lights so as to avoid the casting of extraneous shadows on the work.

The Committee are of opinion that the general statutory requirement of "adequate and suitable lighting" should include the observance of the last three conditions, in addition to the provision of a sufficient amount of illumination, and that power should be given to secure compliance with them in cases where their neglect clearly renders the lighting "inadequate and unsuitable" in any of the particulars given above. Special emphasis may be placed upon the avoidance of glare, of excessive contrast, and flickering lights.

It is pointed out that standards of adequacy in regard to temperature and ventilation of factories already exist. Similarly, in connection with lighting, standards could be based on the "foot-candle." The Committee point out, however, that although intensity of light at the working plane is a most important factor of adequacy and suitability, it is not the only one by any means, and special consideration must also be given to the other factors mentioned above.

A distinction must also be drawn between the illumination required for the purposes of carrying out work and the illumination necessary from the standpoint of general convenience and safety. Whatever be the light required for the work it is necessary that the working area should be illuminated sufficiently for obstacles, dirt and waste, to be clearly visible; whilst in all industries, particularly those in which the work involves danger, it is essential that the general illumination should be sufficient to avoid risk of accidents. Ample illumination for the requirements of the work itself

must be provided beyond the minimum general illumination needed for these purposes.

In the appendix to the report particulars of the illumination existing in a few select trades, namely, clothing, engineering, and textile industries, are summarised, and form, it is believed, a unique analysis of existing industrial lighting conditions. It is, however, obvious that the amount of illumination required for carrying out work will depend on many different factors. In cotton weaving, for example, the optimum illumination varies with the colour of the yarn, the fineness of the yarn, the style of the weave, and other circumstances, and a single standard prescribed to cover cotton weaving generally would err, in some instances in the direction of prodigality, in others of insufficiency.

For the moment the Committee think it is desirable to reserve any expression of opinion as to the minimum amount of illumination for special purposes. They consider, however, that standards may reasonably be proposed regarding the general illumination. For this purpose, what is aimed at is a value which may reasonably be enforced as a statutory minimum, rather than what is now the average practice. From the data relating to the illumination existing in factories, the "mid-point" (or point above and below which an equal number of observances lie) is 0·45 ft. candle. As a statutory minimum value, the Committee recommend that :—

2. Over the "working areas" of workrooms the illumination measured on a horizontal plane at floor level shall not be less than 0·25 foot-candle, without prejudice to the illumination required for the work itself.

Attention has been called to the special difficulties which would be caused if a ship under construction or repair were considered for the purpose of this regulation as part of the working area of a factory, and it is, therefore, proposed to reserve for future consideration the question of the illumination to be provided in ships. Special provision will also be necessary for certain workrooms, where the prescribed illumination would interfere with the proper carrying out of some process, such as the manufacture of photographic materials.

Iron Foundries.

The question of iron foundries also requires special consideration. It appears to be that the illumination in foundries is at present below the average of other workrooms ; although the dark surroundings indicate the desirability of special good lighting in such work, and the Committee are of opinion that a minimum illumination of 0·25 ft. candle is not sufficient for safety. They accordingly recommend that :—

3. In all parts of iron foundries in which work is carried on or over which any person is ordinarily liable to pass, the illumination measured on a horizontal plane at floor level shall not be less than 0·4 foot-candle.

Passages, Stairways, Lobbies, &c.

On the other hands for the lighting of passages, stairways, lobbies, &c., a lower illumination should suffice than in the case of workrooms, since obstacles are usually absent, and the eye is not subjected to the same degree of contrast. Nevertheless many instances of defective lighting were noticed and complaints were received from witnesses on this point. The experience gained from visits to factories indicates the desirability of adopting for these spaces a standard of not less than 0·1 ft. candle. Instances requiring special latitude (such as long passages free from all abrupt changes of level and adequately lighted by the "beacon" system) are dealt with separately under recommendation number 6. It is accordingly recommended that :—

4. In all parts of factories and workshops (not included under recommendation 2) over which persons employed are liable to pass, the illumination measured on the horizontal plane at floor level shall not be less than 0·1 foot-candle.

Open Yards and Approaches.

Here the object of the lighting is to enable a person to see sufficiently well not to stray from the path, and may be compared with that of streets. For any locality where persons are employed at night and for a path or road to which it is necessary to keep, in order to avoid danger (such as an approach leading through a yard containing obstacles), the Committee are of opinion that a minimumillumination equivalent to that of a fairly well-lighted side street (0·05 foot-candle) will be sufficient.

Approaches over clear ground (free from projecting rails or other obstacles and from steps or other abrupt changes of level) where momentary straying from the path involves no risk, and also fenced-in roads, can be adequately lighted by the "beacon" system, namely the spacing of light sources along the direction of the path at such long intervals that they serve as beacons or guides rather than means of illumination. These would not be "dangerous parts" in the intended sense of the next paragraph.

In docks, both places of employment and approaches are already subject to a requirement for adequate lighting in general terms (Regulations for Docks, Reg. 3). It is recommended in accordance with this precedent, that :—

5. In all open places in which persons are employed during the period between one hour after sunset and one hour before sunrise, and in any dangerous parts of the regular road or way over a yard or other space forming the approach to any place of work, the illumination on a horizontal plane at ground level shall be not less than 0·05 foot-candle.

The case of ship-building yards require special consideration, and is reserved for a future report.

In order to meet exceptional circumstances in which the standards proposed in recommendations 2, 3, 4 and 5 might cause hardship, it is recommended that :—

6. There shall be power for the Department to allow exemption in individual cases.

Finally the Committee emphasise the importance of keeping window screens clean and making the following general provisions :—

7. All external windows of every workroom shall be kept clean, on both the inner and outer surfaces,

but in order to meet exceptional cases (as below), there should be power to substitute for the above a definite and binding scheme for cleaning the windows at reasonable fixed intervals, where for example :—

(A) the windows, or some of them (*e.g.*, roof windows) are not readily accessible ; or

(B) The total surface of external windows is exceptionally large in relation to the floor space ; or

(C) The conditions of work are such that compliance with the ordinary requirement is, in consequence of the nature of the work, impossible.

Conclusion.

In concluding their report the Committee make the following remarks which we reproduce *in extenso* :—

"In submitting these recommendations we realise that the standards proposed by us appear to be lower than the values put forward by various lighting experts who have given evidence before us. Some of the latter referred to the general illumination at the working level, where the values are naturally higher than at the floor level, and in any case we have felt that they were intended as an indication of ideal conditions, whereas it has been our object to suggest numerical values that can be adopted as a practical legal minimum without causing hardships. It must be remembered that in view of the diversity of illumination which always exists, whatever the system of lighting, any minimum value will usually connote a very much higher maximum and average, so that with a given minimum the efficiency of the illumination depends to a large extent on this diversity. A workroom, for instance, in which the illumination is uniform and has the value of only 0.25 foot-candle, may be regarded in most cases as very inadequately lighted. We desire, therefore, to point out that none of the recommendations made by us is intended to supersede the requirement of general adequacy and suitability, which, as already explained, depend on several factors in addition to the amount of illumination.

The evidence before us from witnesses and our own observations do not justify us in drawing any distinctions in the present recommendations between direct, indirect, or semi-indirect systems of lighting, or between systems which differ in the colour-composition of the light. We suggest, therefore, that the standards proposed should be adopted irrespective of the type of lighting. Similarly, the evidence does not justify us in discriminating between natural and artificial lighting, and in the recommendations submitted by us, the standards are intended to apply equally to both, that is to say, when the natural illumination falls below the limits proposed, it must be supplemented or replaced by artificial illumination.

The more specific recommendations of this Report may be said, broadly, to deal with the general lighting of factories and

workshops; in other words, they have for their object the maintenance in all workplaces of certain standards of illumination primarily intended to ensure the personal safety of workpeople moving about the premises. In the great majority of factories, however, the standards of general lighting suggested here would be inadequate for the actual machines and work benches where the various manufacturing processes are carried on, and local lighting in addition is generally essential. As already mentioned, we are not prepared at present to suggest values for the minimum illuminations which may be regarded as adequate for special processes.

It was originally our intention to supplement the data already collected for the clothing, engineering, and textile trades, and to extend our inquiries on similar lines so as to include other industries. In view, however, of the present economic disorganisation we think it desirable to submit an interim report of the work already done, and to await settled conditions before prosecuting the inquiry.

The data given in several of the appendices will help those engaged in designing new factories and in examining the adequacy of lighting in existing buildings. At present there are few collated data of this character available, and the desire not to withhold them longer from publication is a further reason for the submission of a preliminary Report at this stage."

(Signed) R. T. GLAZEBROOK (*Chairman*), L. GASTER, J. HERBERT PARSONS, C. S. SHERRINGTON, W. C. D. WHETHAM, ARTHUR WHITELEGGE.
D. R. WILSON, C. C. PATERSON, *Joint Secretaries.*

INFORMATION IN APPENDICES.

The Report itself occupies 19 pages, but it is followed by a valuable series of 16 appendices, filling 67 pages in all. We can only give a very general summary of the contents of these appendices, but they well deserve study.

LIST OF WITNESSES.

The complete list of the witnesses examined, 50 in number, is given as follows:—

(1) OFFICIAL.

1. G. Bellhouse, H.M. Superintending Inspector of Factories.
2. W. Williams, H.M. Superintending Inspector of Factories.
3. J. A. Hine, H.M. Superintending Inspector of Factories.
4. Miss R. E. Squire, H.M. Senior Lady Inspector of Factories.
5. H. J. Wilson, H.M. Inspector of Factories.
6. H. Kenwood, Medical Officer of Health for Stoke Newington.
7. T. W. Heywood, Certifying Surgeon, Darwen.

(2) PROFESSIONAL, TECHNICAL AND SCIENTIFIC.

(*a*) *Illuminating Engineering Experts.*

8. J. G. Clark and How, Gas Light & Coke Co.
9. H. C. Wheat, British Thomson Houston Co., Ltd.
10. Albert Stokes, South Metropolitan Gas Co.
11. A. P. Trotter, Elec. Adviser, Board of Trade.
12. T. E. Ritchie, The Union Electric Co., Ltd.
13. A. J. Whyte, and J. Angus, Messrs. Jas. Keith and Blackman, Ltd.

(*b*) *Representatives of Professional and Scientific Societies.*

14. Haydn T. Harrison, Illuminating Engineering Society.
15. V. H. Mackinney, Illuminating Engineering Society.
16. J. S. Dow, Illuminating Engineering Society.
17. A. Siemens, Institution of Electrical Engineers.
18. Franklin Thorp, Institution of Gas Engineers.

(*c*) *Architects and Surveyors.*

19. P. J. Waldram, London.
20. W. E. Potts, Manchester.
21. J. B. Gass, Bolton.
22. Lewis Solomon, London.
23. Segar Owen, Warrington.
24. H. Hartley, Liverpool.

(*d*) *Medical.*

25. F. W. Edridge Green, Ophthalmic Surgeon.
26. W. McDougall, Physiologist.
27. F. R. Cross, Ophthalmic Surgeon.

(3) REPRESENTATIVES OF TRADE ASSOCIATION.

(*a*) *Employers.*

28. John Taylor, Cotton Spinners and Manufacturers.
29. H. L. Symonds, London Chamber of Commerce.
30. John Carr, London Chamber of Commerce.
31. S. A. Russell, London Chamber of Commerce.
32. W. A. Hughes, Fine Cloth Manufacturers' Association.
33. Robert King, National Light Ironfounders' Association.

34. John Allen, National Federation of Merchant Tailors.
35. John Dewrance, Engineering Employers' Federation.
36. Fred Skull, High Wycombe & District Chamber of Commerce.
37. William Eccles, High Wycombe & District Chamber of Commerce.
38. Thomas Harrison Thorpe, Derby Chamber of Commerce.

(*b*) *Operatives.*

39. R. Trebatcoff and A. Hillman, Jewish Tailors' etc., Trade Union.
40. Thomas Shaw, Amalgamated Weavers' Association.
41. W. C. Robinson, Beamers', Twusters' and Drawers' Association.
42. A. Hutchinson, National Union of Stove Grate Workers.
43. R. Girvan, Scottish Operative Tailors' Association.
44. A. Smalley, Operative Bleachers' etc., Association.
45. F. Lockyear, Ironfounders' Society.
46. C. Wardle, Operative Lacemakers' Society.
47. W. Hartshorn, National Hosiery Federation.

(4) MISCELLANEOUS.

48–50. Three Working Tailors.

STATISTICS FOR THE CHIEF INDUSTRIES.

In Appendix II. we have a complete list of the textile, engineering, clothing, and miscellaneous factories visited.

Following this we have a summary of the number of people employed in the various industries of the country. It is interesting to notice that the total number of persons employed in the textile industries alone is *one million*, while in miscellaneous industries (factories and workshops in which more than fifty thousand persons are employed), we find that the total number of persons employed exceeds four millions. The highest aggregate in this section falls under the heading of engineering, which employs approximately five million thousand hands. These figures will give an idea of the importance to the community of any matter affecting the welfare of employees as a whole. We see by these figures that, even excluding the smaller factories throughout the country, five million people are directly concerned.

GENERAL INFORMATION ON FACTORY LIGHTING.

In Appendix III. there is reproduced a circular letter addressed to 77 Trade Associations throughout the country, with a view to obtaining information of special interest to the Committee. As an indication of the kind of evidence required the letter suggests the following points :—

(*a*) The possibility of defining and establishing a standard or standards of adequate illumination suitable for the various operations and processes in the trade represented by your Association.

(*b*) The classification of processes in relation to the illumination required.

(*c*) The enumeration of the various processes in which specially good illumination is desirable, and information as to means of securing it.

(*d*) Examples of processes presenting special difficulties in respect of efficient lighting, owing to the relative positions of the work and of the light sources, or for other reasons.

(*e*) Particulars of the methods of illumination in general use, with details of special systems which have been adopted for special processes.

(*f*) The relative merits of daylight and artificial illumination, and the extent to which the latter is used, depending on the usual period of employment in the industry represented by your Association.

In addition to the circular letter referred to above, H.M. Inspectors were requested to forward information on such points as the following :—

(*a*) Processes requiring exceptionally good light, by reason of the fineness of work, colour of material, or other circumstances, and the arrangements made to meet this.

(*b*) Processes in which there is exceptional exposure to glare, and for what reasons.

(*c*) Processes in which the lighting is generally inadequate, with detail of a few of the worst examples met with.

(*d*) Examples of special means of lighting, or of protection from glare, and their efficiency.

Reports were received from 30 districts out of a total of 51. Many industries are mentioned as requiring exceptionally good light on account of the nature of the work. For example, Cotton Clothing Factories, Letterpress Printing, Engraving, Machine Sewing, Embroidery, Clock and Watch Making, Electric Glow-lamp Making, &c., &c. Among the trades which require an exceptionally good light, on account of the colour of the material, are mentioned : Black Silk Weaving, Calico-Printing, Pottery-Making, and Paint-Mixing. Next there are mentioned industries in which cleanliness and good sanitary conditions are of exceptional importance, such as Laundries, Bakehouses, Confectioners, Wool-Sorting, and the manipulation of dangerous wools and hides. Industries in which the avoidance of accidents require special care include Dry cleaning (danger of fire), Power Press Processes (metal-box making), and Iron Foundries.

A number of processes are mentioned in which there is exceptional exposure to glare. For example, we have—

(*a*) Processes involving of molten or hot metal or glass.

(*b*) Processes involving the examination of incandescent surfaces such as gas works (retort houses), cement works, electric glow-lamp and incandescent lamp factories, etc.

(*c*) Processes in which electrical discharges take place.

(*d*) Processes in which glare is liable to be caused by the position of the light source, such as :—

Letterpress printing works (composing frames).
Wholesale tailoring (sewing machines).
Hemstitching (sewing machines).
Boot factories (various machines).
Motor-repair works (use of portable unshaded lamps).
Photography by arc or flash light.
Hollow ware turning (the room is purposely darkened and a lamp placed in the opening of the ware, in such a position that the light source is between the workers' eye and his work).
Silver and electro-plate works (burnishing, owing to mirror reflection from the polished surface).

Finally, there are a number of processes in which the lighting is frequently inadequate, such as cotton spinning mills, iron and tin plate mills, foundries, ship-building and repairing works, underground bakeries, and basement rooms in factories. This appendix also contains a note of some interesting devices for mitigating the effects of glare, such as the use of large white reflecting surfaces as a background, or of white tissue paper to diffuse the light, the use of smoke glass, &c.

In Appendix VI. we find a series of past reference to lighting in various reports and investigations, among which the Report of the Departmental Committee on Accidents in Factories and Workshops receives special mention. The evidence in this report specifies a number of processes and industries in which the risk of accidents is accentuated by insufficient light. We also find here a reference to the following industries in which insufficient light tends to cause unsanitary conditions, and for which adequate lighting is required in general terms :—

Fruit Preserving.
Bakehouses (underground).
Vitreous enamelling of metal or glass.
Metal Grinding with wet stones.

Existing Requirements regarding Lighting in Factories, Schools, &c., in Various Countries.

Appendix VII contains quotations of the existing requirements as to the Lighting of Schools and Factories in the British Empire and in the legislation with regard to factories of this country. Appendix VIII. contains similar information regarding foreign countries.

The general conclusions to be drawn from these regulations have already been mentioned in the Report. Readers of the Illuminating Engineer will recall that the regulations of the Board of Education, with regard to Schools, came before the notice of the Joint Committee, appointed by the Illuminating Engineering Society in 1912, to consider this subject.* A useful summary of the factory legislation in various countries, bearing on lighting, was given some years ago in a report presented to the Conseil d'Hygiene de la Seine.† In some cases these regulations have since been modified, and the latest references to them are here given *in extenso*. Most of the requirements, with regard to factories, schools, and other buildings in the United Kingdom, have to deal with daylight illumination, and prescribe the amount of window space and similar matters. Of special interest is the following from the Factory Act in New South Wales, which prescribes a definite standard :—

Every part of a factory in which persons are employed, or any passages or portions of a factory which may at any time be used by an employee, must have light equal to 10 *candle meters, that is, light equal to that given out by an ordinary stearine of paraffin candle of six to the lb., at a distance of* 12 *inches from the flame. When such lighting is found by test to be below that standard, the Inspector may require the occupiers to make provision (preferably where possible by window openings or otherwise) to provide the natural or artificial lighting necessary to bring the lighting up to the standard named above.*

Another section of the appendix contains a summary of the requirements as regards lighting in the following countries : Austria-Hungary, Belgium, Denmark, France, Germany, Holland, Italy, Norway, Sweden, and the United States of America. In most cases we find that the regulations are of a general character, and refer mainly to daylight illumination. As a rule " adequate lighting " is required in general terms, and in some instances special recommendations are made with a view to avoiding any possibility of fires arising through the use of artificial light among inflammable

* *Illum. Eng.*, London, July, 1914.

† *Illum. Eng.*, London, Vol. II., 1909, pp. 292, 373.

materials. It is to be noted that in several countries, for example, Belgium, Denmark, and Holland, the requirement of adequate lighting is particularly emphasised in view of danger arising through insufficient lighting. Thus in Belgium, it is stated that :—

All places where any work is carried on, or over which persons are liable to pass, shall be illuminated sufficiently to enable machinery, transmission gear, and other sources of danger to be distinguished.

The lighting of the plant and appliances used in the places specified in the preceding article shall be so installed, arranged, and maintained as to afford all possible security to the persons employed.

In Holland, in the case of certain processes involving fine work (such as embroidery, sewing, composing, draughtmanship, working in gold, silver, and precious stones), an intensity of 15 metre-candles is prescribed; in other processes requiring good light the illumination must be at least 10 metre-candles. Furthermore, a young person or a woman must not be employed in a factory or workshop unless it fulfils certain conditions. For example :—

(*a*) *In any workroom which is not adequately lighted during the period of employment ;*

(*b*) *At any place of work which cannot be protected from the direct rays of the sun, if the district inspector of factories is of opinion that the conditions would be injurious to the young person or woman ; and*

(*c*) *In workrooms in which during the time between 9 o'clock in the morning and 3 o'clock in the afternoon artificial light must be used in order to obtain adequate illumination, except in so far as exceptional meteorological conditions make the use of artificial light necessary.*

Another interesting point is that in the case of young people or women, the illumination presented is increased to 30 metre-candles in the case of fine work, and 20 metre-candles in the case of ordinary work.

In addition to the general requirement, special conditions as regards lighting are being made for certain industries, and it is laid down that the illumination must be sufficient to enable the persons employed to find their way about in safety.

In Norway, again, the need for good illumination as a matter of safety is recognised in the requirement :—

All workrooms shall be adequately lighted by natural or artificial means, in such a way that all moving parts of machinery involving, when in motion, danger to persons employed, may be clearly distinguished.

In all workrooms in which explosive or readily inflammable gases, fumes or dust are or may be generated, artificial lighting shall be produced by appropriate means.

In Sweden the only legal requirements occur in a recent Act for the protection of labour, which enacts as follows :—

For the prevention of accidents arising from work the employer shall observe the following regulations in particular :—

(*a*) *Satisfactory illumination shall be provided.*

For the prevention of illness arising from any process the employer shall observe the following requirements in particular :—

(*b*) *The work shall be carried on in a suitable and sufficient light.*

More precise instructions are contained in two circulars distributed from the Swedish Factory Department :—

Adequate lighting must be provided not only for workrooms and workplaces, but also for stairways, passages, and transmission gear rooms.

Workrooms should be provided with good natural lighting.

Artificial light should be convenient and adequate. During working hours all moving parts of the machinery and all obstructions on the floor which might be productive of danger, hoist and stair openings, breaks in the floor and similar openings, should be well lighted.

Stairways, passages, and yards should always be adequately lighted.

In France the existing requirements appear to be mainly concerned with the safety of the illuminants as regards fires. It is also required that :—

" *All indoor premises used for the carrying on of work, their annexes. and especially the passages and stairways, shall be adequately lighted.*"

In Germany we find among the Imperial requirements :—

" *In particular care must be taken to provide adequate lighting.*"

While in the Austrian Empire, the new Factory Act requires employers " *to provide the workrooms and shops with adequate artificial light.*"

Reference is also made to the necessity for keeping premises as free from dust as possible.

The question of lighting does not appear to have received very much attention in the legislation of most of the United States of America, but there is in most instances a Factory Inspection Law, in which the inspectors are required to satisfy themselves, amongst other things, that the lighting arrangements are adequate for the well being of the

persons employed. Most of the requirements specified by the authorities relate to daylight illumination, prescribing the amount of window space, &c.

In the State of California there is a special provision with regard to unhealthy basements, cellars, or underground apartments used as workshops.

Particulars are also given of the requirements for the lighting of schools in some countries. In this respect also Sweden appears to give an exceptional amount of attention to artificial lighting.

It is stated that :—

In the selection of artificial light sources, care should be taken that these give sufficient and soft light, without glare and shadows, and it is found that a light source of about 25 candle-power at a distance of one metre is sufficient for reading and writing.

*The lamps must be so placed that the pupils are not compelled to look either straight at them or directly past them. They must, therefore, be fixed sufficiently high and be provided, as a rule, with suitable globes or shades, constructed, for instance, of opal or ground glass.** The Swedish requirements are also of interest, in that they discriminate between the requirements of various types of class rooms.

With regard to daylight illumination, we find that in most cases the recommendations refer to the area and position of windows and the shape of schoolrooms, with a view to obtaining the maximum admittance of light. The height of the window sill is also frequently specified, and in Belgium and Sweden the desirable dimensions of schoolrooms are also indicated. In Europe as well as in several states of America, the desirability of light walls and ceilings is pointed out. Unilateral lighting is generally preferred. Speaking generally, the conditions as regards natural lighting of schoolrooms have received more attention than artificial illumination.†

* It is interesting to observe that these recommendations are in close accordance with those suggested by the Illuminating Engineering Society in this country. (See "The Artificial Lighting of Schools," *Illuminating Engineer*, July, 1913.)

† Here again it is interesting to compare the information collected regarding the requirements of various countries with that published in the *Illuminating Engineer* in connection with the inquiry into the Daylight Illumination of Schools (*Illuminating Engineer*, London, Jan., Feb., and July, 1914).

Relation between Accidents and Inadequate Lighting.

In Appendix IX. there is a study of accidents in factories compiled by the Joint Secretaries of the Committee (Mr. D. R. Wilson and Mr. C. C. Paterson).

In order to discover the relationship (if any) between work with artificial light and liability to accidents, use has been made of a special return of all reported accidents for 1913 and part of 1914, in which the number of accidents occurring each month from the following causes :—

(a) Machinery moved by mechanical power,
(b) Molten metal and hot liquid,
(c) Struck by falling body,
(d) Persons falling,
(e) All causes,

are tabulated for a large number of industries.

In analysing the accidents three general methods have been employed :—

(1) Diagrams have been prepared showing the monthly percentages of accidents due to various causes. In these the accidents from a given cause in any industry are expressed as a percentage of the total accidents occurring in that industry *from that cause, during the full period of* 14 *months, under consideration.*

(2) Diagrams have been prepared, showing for each month the relative number of accidents due to various causes. In these the accidents are expressed as a percentage of the total number *due to all causes* occurring in that industry *during the month in question.*

(3) An attempt is made to calculate normal accident rates from each cause during the months that no artificial light is used, and, by applying these rates in the daylight period of employment during the winter months to estimate the accident rates during the use of artificial light.

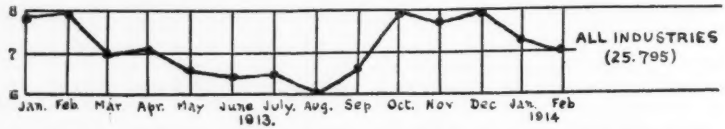
It will be observed that methods 1 and 2 have both their particular advantages. Method 1 is unaffected by changes in the number of accidents due to causes other than the one under consideration. But it takes no account of the number of working hours, nor the number of persons at work in each month.

Method 2, on the other hand, eliminates the effect of the variations in the number of persons working and the number of working days. But the true character of the curve may be masked by changes in the number of accidents occurring in the industry from causes other than that under consideration.

In the report a series of diagrams prepared by each of these methods is given. The curves based on method 1 show a

general drop for August, due, doubtless, to the holiday season. Generally speaking, the curves do not possess any characteristic form, *excepting for accidents due to persons falling.* In this case, as is shown by the curve we reproduce, there is a marked increase in the number of accidents during the winter months. This would appear to be a natural result. For, of all the varieties of accidents mentioned, those resulting from people falling seems most likely to be effected by insufficient illumination. On the other hand, there are certain sections, such as the construction of buildings, which are practically daylight industries, and in these, these considerations serve to show the necessity for careful analysis in considering statistics of accidents.

In applying method (3) certain assumptions are made as to the hours of working, and the period during which artificial light is applied. On this basis a summary of the accidents during daylight and artificial light can be prepared, and in the following table we give the results for persons falling and other accidents due to all causes.



Accidents due to persons falling. Showing marked increase in number of accidents during the winter months, when artificial light is mainly used.

Causation.	Industry.	Total accidents. Summer months (excluding August).	Total accidents. Winter months.	Daylight Accident Rate per Hour deduced from summer months).	Accidents during winter months. Daylight.	Accidents during winter months. Artificial.	Artificial light Accident Rate per Hour	Percentage of difference between Daylight and Artificial light Accident Rates.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Persons falling	Textile	694	980	0·58	580	400	1·01	+76
	Founding	193	287	0·161	161	126	0·32	+99
	Shipbuilding ..	1,276	1,898	1·06	1,065	833	2·12	+99
	Drink	202	270	0·16	169	101	0·25	+52
	Docks	715	1,072	0·59	598	474	1·20	+102
	Building	274	330	0·22	229	101	0·25	+12
	Engineering ..	1,334	1,895	1·10	1,107	788	2·08	+93
	Other industries not specified ..	3,893	5,240	3·25	3,250	1,990	5·06	+56
	All industries ..	8,581	11,972	7·16	7,159	4,813	12·32	+71
	Textile	7,380	9,744	6·17	67,165	3,579	9·11	+46
	Wood	1,871	2,320	1·56	1,563	757	1·93	+24
	Founding of Metals	3,562	4,217	2·98	2,976	1,241	3·16	+ 6
	Shipbuilding ..	7,355	9,094	6·15	6,144	2,950	7·51	+22
	Drink	965	1,233	0·81	806	427	1·09	+35
	Docks	4,052	5,402	3·39	3,385	2,017	5·13	+01
	Buildings under construction ..	833	926	0·70	696	230	0·08	+17
	Engineering ..	16,570	20,838	13·76	13,942	6,896	18·20	+32
	Remaining industries not separately scheduled ..	30,799	38,491	25·75	25,728	12,763	32·48	+26
	All Industries ..	73,387	92,265	61·27	61,405	30,860	79·17	+29

It will be observed that in nearly all cases the accident rate by artificial light is very considerably greater than by daylight. The difference is particularly marked in the case of accidents due to persons falling. In the founding, ship building, docks, and engineering trades, the increase of accidents due to this cause is in the neighbourhood of 100½ per cent. The smallest increase occurs in the case of the construction of buildings for which, being a daylight industry, no difference is to be expected.

In addition we reproduce a table, giving particulars of fatal accidents per month in mines.

AVERAGE NUMBER OF FATAL ACCIDENTS PER MONTH IN MINES.

	Summer	Winter	Percentage Difference
1912.			
Underground	110	88	—20
Surface ..	14	18	+29
1913.			
Underground	91	89	— 2
Surface ..	11·2	16·2	+45

It is interesting to notice the radical difference in the number of accidents underground and on the surface. During 1913, for example, the number of accidents underground was slightly *less* during the winter than in the summer; whereas on the surface the number of accidents in winter was as much as 45 per cent. greater than in the summer. This seems to point strongly to the conclusion that the conditions of illumination are a material factor in the causation of accidents.

THE EFFECT OF ILLUMINATION ON VISUAL ACUITY.

Appendix X. contains an article on "The Influence of Lateral Illumination on Visual Acuity," by J. Herbert Parsons, a member of the Committee, which is reprinted from the Royal London Ophthalmic Hospital Reports (Vol. xix., Part 111).

The paper contains a summary of various researches which bear on the relation between illumination and acuteness of vision, reference being made to the well-known experiments of Uhthoff in 1885.

An important point is the effect of adjacent lights on the impression received by the eye. This has been studied by Cobb in the United States, who remarks that "light from a bright source entering the eye reduces the visibility of an object more, the brighter the source, the lower the brightness of the object and the smaller the angle subtended by the two." The effects are very complicated, however, and in special circumstances high lateral illumination may actually increase visual acuity. It is pointed out by Cobb that the unpleasant feeling of dazzling and the disturbance of vision produced by dazzling are quite different things, and, apparently, are also distinct from the effect of bright light on visual acuity.

Appendix XI. contains an extract from Professor Snellen's Bowman Lecture in 1896. This is of considerable interest historically, as it shows that even at that early date a standard of illumination for factories and workshops was under consideration. The following is the extract:—

> Another subject on which these observations may throw light is the question, "What intensity of light is required for trades in which a good visual acuity is essential?"
>
> We were led to start these observations by a question to this effect addressed to us by our Government. In obedience to Art. 6 of the law of 20th June, 1895, on factories, regulations were wanted for the required illumination of factories and workshops, and the question submitted to us was: "Is it possible to determine the maximum amount of light necessary to the workman with normal eyes for a certain sort of work And, further, is such an amount of light is to be determined, is there a practical method to measure that amount?"
>
> To answer these questions we set to work in a practical way, and repaired with the photometer to workshops, in order to determine the intensity of daylight at different times, and further, when twilight begins to fall, to ascertain where at the waning of daylight the want of light begins to impede the man's work. In a printing business we found this to be the case for compositors when the illumination sinks below 15 m.c. With an intensity of 15 m.c. a visual acuity of 6/6 is the extreme limit. As a rule, all work is arranged so that it can be done at this vision. But for the man to have his whole visual acuity at his disposal, it is necessary that in the long run a much greater intensity of light should be afforded.
>
> If, however, the intensity of light at dusk is not to fall below 15 m.c., we shall be sure to have in the daytime an intensity of between 30 and 50 m.c. In answer to the questions which were laid before us, we came to the following conclusions:—
>
> "That in every workshop a minimum amount of 15 m.c. is necessary for work resembling reading, whereas a minimum of 10 m.c. will do for coarser work, *e.g.*, that of carpenters and blacksmiths; that in broad daylight the required amount is between 30 and 50 m.c., and

that it must be possible to exclude direct sunlight. The determination of the intensity can be done best by means of a Weber's photometer."

Following this we find results of a series of enquiries among ophthalmologists and ophthalmic surgeons undertaken by F. R. Cross, F.R.C.S., with a view to obtaining statistics or information as to the prevalence of eye trouble among people in various trades. In some cases insufficient light is regarded as aggravating effects of strain on the eyes. Many of the replies lay stress on the need for careful distribution of lights and proper methods of shading; others mention various methods of protection employed by glass-blowers, electric-welders and others, who have to deal with intensely brilliant lights.

A circular letter has also been addressed to various associations concerned with fine work, asking for information of specific cases of injury to the eyesight caused by working with insufficient light or with a badly-arranged system of lighting.

Here again it appears difficult to trace specific instances, for the opinion is expressed that bad eyesight would certainly follow in any case where work-people had a strain on their eyesight through the fault of bad lighting; at various times complaints have been made by weavers at certain mills of the difficulty of following their work on account of the bad lighting.

The remaining appendices are devoted mainly to the special researches carried out by the Committee. These fall into two parts; the experiments made at the National Physical Laboratory and the tests carried out in various factories throughout the United Kingdom.

Experiments at the National Physical Laboratory.

The experiments at the National Physical Laboratory deal with a number of points of which opinions have often been expressed, but on which few data have hitherto been available. The tests were carried out in a room with white walls, which, however, could be screened with black curtains when it was desired to test the effect of reflection. Three systems of illumination were installed: (1) *Direct lighting* by unobscured metal filament lamps with ordinary opal glass shades, (2) *Indirect lighting* by metal filament lamps in inverted white reflectors, (3) *Shielded lighting* in which lamps, similar to those in system (1) were enclosed in illuminium shades of approximately parabolic form, which completely shielded the eyes from the direct rays of the lamps. By means of resistances placed in circuit of the lamps, any degree of illumination up to the maximum of approximately 12 ft.-candles (underneath the lamps), can be obtained.

Effect of Absorption of Light by Material.

Some tests were carried out on seam-stresses taken from the workrooms of some of the principle outfitters and also tailors from the East End. The operators were asked to work on various materials, varying in hue from white to black, and an attempt was made to ascertain the order of illumination which was considered by the operators satisfactory in each case. Speaking generally, about $5\frac{1}{2}$ ft.-candles was found to be necessary for black material, whilst $1\frac{1}{4}$ ft.-candles appeared the minimum necessary for white calico. Colours intermediate in hue between these extremes required intermediate values of illumination. The results obtained suffice to indicate the correctness of the relation:—

The coefficient of reflection × necessary illumination = constant.

In other words a minimum surface brightness of the material worked in should be aimed at.

Observations were also made by the Committee on the appearance of type on cards of various colours. It was again found that the colour had a definite influence on the illumination required; whereas the smallest type on white cards could be read with an illumination of $\frac{3}{4}$ ft.-candle, similar figures on dark blue cards could not be seen with an illumination of 6 ft.-candles.

Speaking generally, an illumination of 3 to 4 ft.-candles gives the impression of a well-lighted room, whilst from 0.1 to 0.25 ft.-candles would be the order of illumination which would suffice for corridors.

Experiments on Glare.

Experiments were also made to test the effect of glare. It is pointed out that the effect of a bare lamp in the direct range of view depends very materially on the intensity of illumination in the neighbourhood of the observer. For example, in one case observers were asked to study a test card while a 100 candle-power lamp was placed in front of them, in such a way that the vertical distance between the lamp and the test card subtended an angle of 20 degrees at the observer's eye.

The time required to read the figures on the cards with the lamp present and removed was noted. It appeared that when the illumination on the card was only 0.5 ft.-candles the glare from the expressed source of light rendered it practically impossible to distinguish them; but when the illumination was over 2 to 4 ft.-candles there was no diminution of ability to read the figures. (This experiment suggests an additional reason for desiring a high value of illumination on the work, namely, that insufficient illumination, besides adding to the difficulties of perceiving detail, also accentuates the effect of glare.)

Comparison of Direct and Indirect Lighting.

Another very interesting series of experiments was conducted on the effect of direct and indirect lighting. As far as the observation of the type on cards is concerned it would appear that there was no difference in the two cases, provided the direct lights were so placed that inconvenient reflection of light from the card was avoided. But in the case of fabrics with irregular surfaces, embossed papers, engraved copper plates, etc., it appeared that a considerably greater illumination was required by indirect illumination than by direct lighting. In these cases the perception of detail apparently depends mainly on the contrast between the brightness of the ground surfaces, and that of the shadows cast by the embossed detail, or on the variation of brightness over the surface of such detail. The preference for direct lighting may, therefore, be due mainly to the fact that the shadows shown by indirect light are less intense, and that the variation of illumination over a curved surface is much less marked with diffused light.

Some of the main conclusions arrived at as the result of these experiments are as follows:—

(1) The illumination required for the perception of detail in materials having a low coefficient of reflection is greater than for those which reflect more strongly and other things being equal is inversely proportional to such coefficient of reflection; that is to say, for equal visibility there must be constant surface brightness.

(2) The visibility of detail in self-toned portions of fabrics, embossed paper, and similar substances, depends on the unidirectional character of the light illuminating them. It follows and has been shown experimentally that the ability to distinguish detail in such substances is for the same illumination much greater by direct than by indirect light.

(3) Work such as sewing may be comfortably performed on the darkest materials with an illumination of 5 to 6 ft.-candles (direct lighting). For white calico 1¼ ft.-candles was found sufficient, and intermediate shades were found to lie between these values.

(4) The observations on the phenomena of glare have not as yet yielded definite numerical results. They have shown, however, that the presence of a bright lateral light, although causing a feeling of annoyance, does not actually diminish ability to distinguish detail unless the surface brightness of the object viewed is relatively low.

Records and Summaries of Illumination Measurements in Factories.

Appendix XV. contains a complete account of the sources of measurements made in factories throughout the United Kingdom.

In taking the observations special attention was directed to:—

(*a*) The illumination of floors and gangways;

(*b*) Illumination where work was being carried out.

A distinction has to be drawn between the tests of natural and artificial illumination. Seeing that the intensity of natural light varies from hour to hour and day to day observed absolute measurements are not a very useful method of investigating the admission of daylight, and no records of the illumination on isolated occasions suffice of themselves to afford a criterion by which to judge the illumination. It is necessary to relate the illumination at any moment indoors with the unrestricted illumination outside at the same instant. This relation is expressed as a "daylight factor" for any point in a room, and is a measure of the lighting efficiency of the building at this particular point. Naturally this factor varies very greatly according to the position of windows, but it should be, within wide limits, independent of the time of the year or the external meteorological conditions.

Experience shows that in roof-lighted buildings, such as weaving sheds, the daylight factor is of the order of two per cent. On the other hand, at the centre of some workrooms depending entirely on lateral illumination, the factor falls as low as 0.01 per cent. In Appendix XVI. charts showing the variation in illumination in the course of the day and throughout the year are given. From these

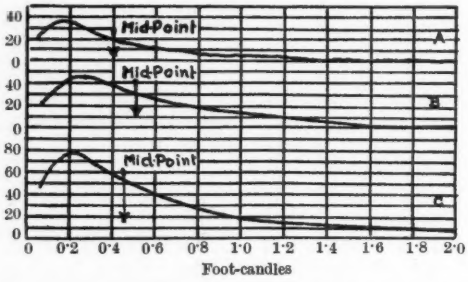
figures it appears that an average day in December the illumination varies from 500 foot-candles at 10 a.m. to 700 foot-candles at mid-day. If the daylight factor at a point in workrooms does not exceed 0·4 per cent., its illumination will only reach two foot-candles from about 10 a.m. to 2 p.m., and at other times of the day it will be below this. Such a room could not be regarded as adequately lighted in December without additional artificial light, although in June, with an outside illumination at mid-day of the order of 4,000 foot-candles, the lighting would probably be satisfactory from 6 a.m. to 6 p.m.

In these curves the illumination is plotted against the number of factories in which a certain value of illumination is encountered. The two principle features to be noted in any one of these curves are :—

(*a*) The mid-point ;

(*b*) The general contour and distribution of area of the curve.

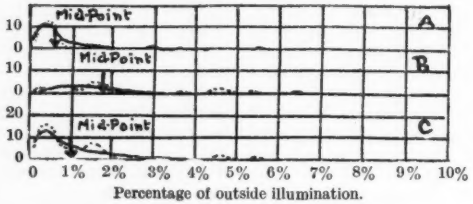
By the "mid-point" is meant the point above and below which there is an equal number of observations. In most curves there is a well defined maximum, which in many instances occurs at a point low down in the scale of illumination. The mid-point is of particular interest in



Frequency of Occurrence Curve for Artificial Lighting of Factory Floors.

A—Foundries. B—Other Factories than Foundries.

C—All Factories visited, including Foundries.



Frequency of Occurrence Curve for Daylight Factors.
Combined Roof and Side Lighting.

A—Foundries. B—Other Factories than Foundries.

C—All Factories, including Foundries.

In analysing the results of these investigations, as regards natural and artificial lighting, the Report makes use of "frequency of occurrence curves," a few of which we reproduce herewith.

view of the recommendations contained in the Report as it gives a fair measure of the average illumination which might be expected in modern factories of a particular class. The following figures are

of special interest as showing the mid-point daylight factors made in several classes of factories :—

	Daylight Factor. Per cent.
1. Roof-Lighting :—	
Foundries	1.4
All Factories, excluding Foundries	2.3
All Factories, including Foundries	1.9
2. Combined Roof and Side-Lighting :—	
Foundries	0.6
All Factories, excluding Foundries	1.8
All Factories, including Foundries	1.0
3. Side-Lighting only :—	
All Factories	0.25

In the following table corresponding figures are given for the mid-point values of artificial illumination as measured on the floors of factories. It will be seen that these values are in general well above the recommended minimum values in the Report.

Factory.	*Artificial Light.* Mid-point on Floor. Foot-candles.
Foundries	0.4
Engineering Shops	0.6
Weaving Sheds ..	0.4
Lace and Hosiery Factories ..	0.35
Clothing Workrooms	0.85
Spinning Mills ..	0.6

A large number of figures are also given for the intensity of illumination encountered at the actual point where the work is carried on. In this case the values naturally vary between wide limits the higher illumination representing exceptionally good conditions of illumination and the lower figures values which would probably be considered insufficient. In the following table we summarise

CONDITIONS OF ILLUMINATION IN VARIOUS FACTORIES.

Nature of Factory.	DAYLIGHT. DAYLIGHT FACTOR %.			ARTIFICIAL LIGHT. FOOT-CANDLES.		
	On Floor.	At Point of Work.		On Floor.	At Point of Work.	
	Mid-Point.	Range of Values.	**Mid-Point.**	**Mid-Point.**	Range of Values.	**Mid-Point.**
TEXTILE—						
A. Weaving	**1·5**	0· 3—5·2	**2·7**	**0·4**	0·98—8·7	**2**
B. Spinning—						
(a) Rooms containing much machinery	**0·8**	0·17—3·2	**0·6**	**0·6**	0·26—5·6	**0·65**
(b) Mill Spinning Rooms		0· 9—3·6	**0·5**		0·11—1·5	**0·4**
C. Lace and Hosiery—						
(a) Lace		0·56—2·0	**0·65**		0·42—2·35	**0·7**
(b) Hosiery ..	**0·35**	0·18—1·6	**0·95**	**0·35**	1· 0—2·4	**1·3**
(c) Winding-machines		—	**0·35**		—	**1·05**
ENGINEERING—						
A. General Engineering						
(a) Machine Shops		0·23—5·2	**1·5**		0·57—10	**1·6**
(b) Rooms for Bench work		0·54—11	**1·8**		0·49—5·8	**1·85**
(c) Forges and Heavy Work ..	**1·2**	0· 3—3·4	**1·0**	**0·6**	0·47—2·2	**1·0**
(d) Woodworking and Pattern Shops ..		2· 1—2·9	—		2· 8—4·4	—
B. Foundries ..	**14·***		**1·4***			
	0·6†	0·58—25%	**0·6†**	**0·4**	0·18—2·3	**0·4**
MAKING UP OF CLOTHING, ETC.—						
(1) Sewing Coloured Cloth		0·44—5·0	**1·6**		0·76—14	**3·6**
(2) Cutting and Pressing	**1·2**	0· 5—1·1	**1·3**	**0·85**	1·45—3·9	**2·0**
(3) Sewing on White Linen		0·27—13	**3·3**		2· 1—5·3	**2·5**

* Roof Lighting.

† Combined Roof and Side Lighting.

in a general form some of the figures given in the Report for the various classes of factories visited.

MISCELLANEOUS INDUSTRIES.

Nature of Work.	Daylight Factor at Point of Work.	Artificial Illumination at Point of Work. Foot-candles.
	%	
Drawing office ..	—	—
Cotton bag-making	0·13	0·25
Tapestry	5·8	3·1
Xmas card printing	5·8	8·2
Print colouring ..	2·9	8·4
Printing	0·16	7·0
"	1·3	1·65
"	0·28	2·20
"	2·5	3·4
"	1·7	0·93
Printing and box-making	0·32	2·70
Box-making ..	3·4	1·2
Chocolate - making and packing ..	0·34	0·83
Cocoa packing ..	0·34	1·2
Chocolate packing..	0·6	0·82
" ..	0·9	0·90
Burling "	5·0	7·0

We may say that the complete data given on this point in the Report are well worthy of study by those concerned with the lighting of these classes of factories.

Appendix XVI. contains a special contribution by Mr. C. C. Paterson and Mr. J. W. T. Walsh on daylight illumination, in which the nature of the daylight factor and methods of measuring it are explained. Of special interest are the curves showing the variation in illumination on average days in June, September, and December and the average illumination for each month during the year. This appears to be the first time that the values have been completely determined experimentally in this country, although corresponding figures have been obtained on the Continent and in the United States.*

The final Appendix (XVII.) contains a brief explanation of the chief essentials of modern illumination photometry.

* *Illum. Eng.*, Lond., Vol. VII., 1914, pp. 15, 79. Vol. I., 1908, pp. 685, 686.

PRACTICAL LIGHTING IN A BLACKSMITH'S SHOP.*

A SIMPLE but effective method of lighting for use in making horseshoes is installed in a blacksmith's shop at Salem (Mass., U.S.A.).

Three round openings, 9.5 in. in diameter, were sawed in the inside boarding of the double wall partition, leaving a space the depth of the joists, about 4 inches. In each opening was placed a 25-watt tungsten lamp, with a concave metal reflector behind it.

The three units are situated 7½ ft. apart, in a row 32 in. above the floor. This location permits the light to shine directly on the work, while the blacksmith is hammering the shoe on the hoof held on his knee, and does away with inconvenient flexible cords.

* *Electrical World*, July 10th, 1915.

SHORT NOTES ON ILLUMINATING ENGINEERING.

THE MELTING POINT OF TUNGSTEN.

SINCE the metal filament lamps first made their appearance there has been much speculation on the melting point of tungsten and the limiting intrinsic brilliancy that might be expected from filaments of this material.

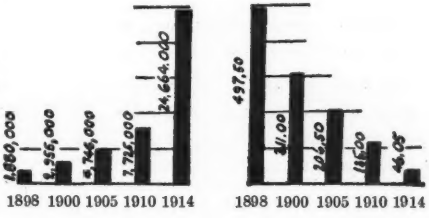
Some light is shed on this point by a recent series of researches by Irving Langmuir,* who brought two tungsten electrodes into a molten condition by the passage of an alternating arc. An intrinsic brilliance of 7,200 candles per square centimetre was attained, and it is estimated that the temperature of incandescence at melting point was very close to 3540° abs. or 3267° C.

Another interesting fact mentioned by Langmuir is the unequal brightness of different portions of the spiralised tungsten filament. The interior portions of the helix appear to have a brightness quite twice that of the external portion. This difference cannot be ascribed to variation in temperature, and is thought by the author to be due to reflection of light in the interior of the helix. This suggests that, other things being equal, the light-giving efficiency of a helical filament will in general be somewhat less than that of a plain wire, owing to the fact that the folds of the helix cause a certain amount of obstruction of light.

* *Physical Review*, August, 1915.

STREET LIGHTING IN CHICAGO.

IN the Annual Report of the Commissioner of gas and electricity for the City of Chicago (1914) detailed costs for the last few years are given, and in a recent issue of the *Electrical World* these are assembled in tabular form and compared with the corresponding amount of light provided. It will be seen that the total candle-power has risen from 1,800,000 in 1898 to 24,664,000 in 1914. Simultaneously the cost per thousand candle-power has diminished from $497.50 to $46.05.



Total candle-power supplied.

Cost (dollars) per 1000 c.p. supplied.

Owing to the advance in modern methods of illumination Chicago is thus getting about thirteen times as much light as was provided 16 years ago; but is only paying for this vast increase about 20 per cent. more than the original sum.

LIGHT AND SUPERSTITION.

SOME years ago we published a series of articles by D. M. Gaster entitled "Light in Custom and Superstition," in which many instances were mentioned of the use of light in connection with ceremonies among primitive peoples, such as weddings and the burial of the dead. In such cases we find a constant relation between the kindling of flames and life—their extinction and death.

Some other interesting examples are quoted in a recent issue of the *Edison Monthly*. "The folk-lore of nations," it says, fairly bulges with references to the lamp, the torch and the candle, which seem, in consequence, to have guided men's actions in the critical occasions of life quite as much as they have directed his footsteps by night."

A Roumanian Wedding.

Decorated candles play an important part of the ceremony and are kept by the bride and groom for the rest of their lives.

It is gratifying to note that among the Romans one goddess, "Esta," paid particular attention to lights, and is believed to be closely related to Hestia, a Greek goddess with similar functions. Besides playing an important part in wedding ceremonies (note, for example, the candles in the illustration of the Roumanian marriage), light is regarded in India as a safeguard against cholera and other sicknesses; "the most obstinate disease will yield if a new earthen pot, clean washed and filled with certain objects, be taken to the cross roads with a light made of threads dipped in oil, and there broken."

Light has also been credited with a certain power over the elements, and candles were kept burning during a thunderstorm.

In Wales they speak of the "canwyll corph," or "corpse candle," which is supposed to visit the home of a person about to die; in Lancashire candles formed an essential part of the ceremony of "lating the witches."

But perhaps the most curious instance of all customs in which candles figure is furnished by the old auction sales in England. It is stated that one such custom was even sanctioned by Act of Parliament, which directed that herbage should be sold by candle light, and that the last bidder, when the light had burned itself out, should be the purchaser.

At such auctions the bidding was stimulated by the frequent exclamations of the auctioneer, "Get on, gentlemen, please, the light's burning."

FAILURE OF LIGHT DURING AN OPERATION.

THE *Pall Mall Gazette** mentions an incident which illustrates very forcibly the risks of total extinction of light during visits of hostile aircraft, and the importance of the recommendations made by the authorities on this point, and summarised in our July issue (p. 302).

During one of the air raids on the East Coast a well-known surgeon was performing the operation of tracheotomy at a nursing home. When the German aircraft came over the town the electric current was at once cut off. All the lights went out suddenly, and this, too, at the very moment when the surgeon in question was opening the windpipe.

Fortunately it was not the first attack delivered against this place, a fishing and seabathing resort. Taught by experience, the operator had made it a matter of habit to warn his nurses and other assistants that lamps should be kept ready for use during all operations which had to be undertaken at night.

This precaution may have saved the smal patient's life. With but a trifling delay the tracheotomy was completed and the child is now doing well.

* Aug. 20, 1915.

A NEW METHOD OF COMPARING SOURCES OF LIGHT WHICH DIFFER IN COLOUR.

ONE method which has been used by many laboratories in comparing sources of light which differ in colour is to insert a coloured transparent screen in front of the standard bringing the hues of the two lights to be compared into practical identity. The amount of light absorbed by the screen must be determined once and for all by a separate and careful investigation. Naturally this involves heterochromatic photometry, with all its difficulties, but the comparison can be made by skilled observers, and personal discrepancies reduced by making observances with a number of different individuals and taking a mean.

In a recent paper before the Illuminating Engineering Society in Germany, Herr v. Pirani suggested a new method of making this determination. The curve of sensibility for the human eye has been determined with great care by Ives in the United States and it is therefore possible to construct the average curve of luminosity throughout the spectrum for the white light.

Now if the absorption of the filter used with the standard light is correctly determined throughout the spectrum by observations with a spectrophotometer, a second curve can be constructed showing the luminosity throughout the spectrum as received through this filter. The comparison of the area of this curve with that of the curve showing the total luminosity, gives a measure of the integral absorption of the filter. The advantage of this method is that no hectrochromatic comparisons have to be made, providing the results for the standard life are accepted. The question may arise whether other observers would obtain exactly the same results, but in view of the great care with which this determination was made agreement seems probable.

Herr v. Pirani describes some experiments on red, green, blue, and violet filters by which the results obtained by the above method were compared with those obtained from direct observation. Even in these extreme cases the order of accuracy was found to be within 3—5 per cent. It is stated that with the type of filter necessary to bring colours of the light used by a half-watt lamp and an ordinary tungsten lamp into equality, results correct to within one to two per cent. may be expected.

THE FIREFLY AND OTHER LUMINOUS ORGANISMS.

SOME interesting data on this fascinating subject were given by A. F. McDermott in a recent paper before the Illuminating Engineering Society in the United States.

The author shows that the power of producing light is quite widely distributed among animals, but is directly observed in certain insects and marine creatures. Observers agree as to the high luminous efficiency of the light from the firefly, estimated to be between 90 and 100 per cent. In many cases the spectrum is continuous within wide limits. The colour, however, varies, being greenish in some cases and red in others.

A most interesting statement is that the tissue of these organisms can be dried and kept for as long as two years without losing their phosphorescence. The chemistry of the processes giving rise to light is somewhat obscure, but the general belief is that the luminosity is due to oxidation. The study of these aspects is most important, as it may enable us eventually to prepare substances giving a permanent luminosity sufficiently great to render them of considerable practical value, for coating powder magazines and in order to render objects in mines, &c., easily discernible.

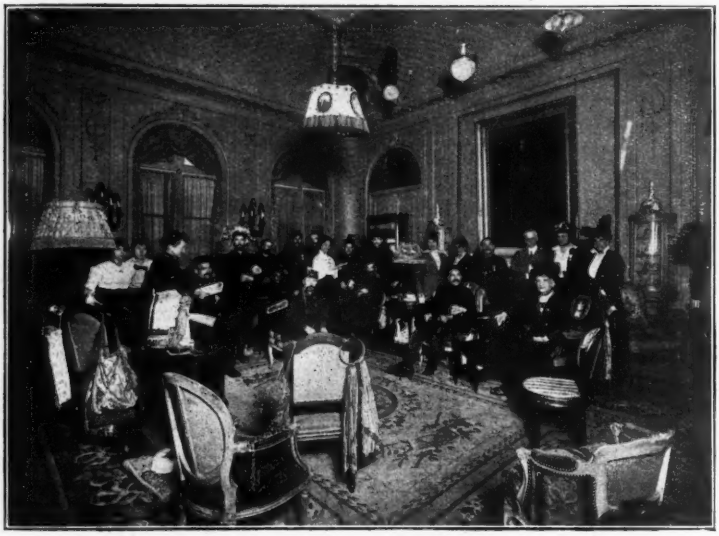
THE HOLOPHANE "OUVROIR" IN PARIS.

In Paris, as in London, there are many "Ouvroirs"—organisations which are doing admirable work in alleviating the lot of the soldiers in the trenches. The Holophane "Ouvroir" at 156, Boulevard Haussmann, Paris, which is managed by Madame Mary King Waddington and Mrs. Otis Mygatt, was among the very first of these institutions to be started after the declaration of war.

One can hardly imagine a more striking illustration of the contrast between peace and war than the gathering in the well-known Paris showrooms of the Holophane Co., shown in the photograph. Madame Waddington and Mr. and Mrs. Mygatt appear on the extreme right; among those present are a number of wounded soldiers who came in while the photograph was being taken.

Every day at least 10 to 20 soldiers call and receive help and comfort in various ways. It is stated that since August 6th, 1914, the sum of 40,000 francs has been spent on clothing which has been distributed to those at the front. Thousands of letters have been received from the trenches expressing gratitude for the services rendered by the "Ouvroir." Many of the writers refer pathetically to friends and relatives who were resident in the invaded area, and whose fate is still uncertain. This anxiety is hard to bear and in the circumstances the friendly assistance of the "Ouvroir" is all the more appreciated.

It is surely appropriate that the Holophane premises, which in peace served as a distributor of lighting appliances, designed to direct the rays of light where they are most needed, should also be a centre from which rays of hope and comfort are conveyed to the troubled minds of our Allies in the trenches. There is no doubt that such help is badly needed and we hope that sympathisers with the movement will see that the good work of the Holophane "Ouvroir" is properly encouraged and supported with adequate funds.



The Holophane "Ouvroir" (Paris). On the right are seen Madame Waddington (seated) and Mr. and Mrs. Otis Mygatt, by whom the "Ouvroir" is managed.

TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

RAILWAY STATION LIGHTING WITH HALF-WATT LAMPS.

In our last issue we referred to the improved lighting at the Caledonian Railway Company's station at Glasgow, which is now lighted by Osram Atmos (Half-Watt) lamps. The illustration shows the general arrangements of these lamps, which have simply replaced the arc lamps previously used and occupy the same positions. As a result there has been an economy of 300 watts on each circuit of four lamps. The illumination is stated to be even and sufficient for the purpose.

It is stated that the illumination in the main hall is now from 1·7—2 ft.-candles, while along the platform values from 0·8—1·6 ft.-candles were recorded. Seeing that a series of measurements carried out some years ago on the main platforms of some of the chief stations in London showed that the minimum was usually of the order of 0·25 ft.-candles, the above values must be considered good lighting and it is evident that the introduction of half-watt lamps is leading to a decided rise in the standard of illumination provided.

A view of the Caledonian Railway Co.'s Station at Glasgow, lighted by Osram Atmos Lamps.

SIEMENS' CONTRACT.

Messrs. Siemens Bros. Dynamo Works, Ltd., inform us that they have received an acceptance of their tender for the supply of Wotan lamps to the Great Central Railway.

HIGH PRESSURE GAS LIGHTING IN AN ENGINEERING WORKSHOP.

In this issue we give another illustration of the lighting on an engineering workshop lighted by high pressure gas, namely the workshop of Messrs. Penrose & Co. in Farringdon Road. The illumination is on the Tilley high pressure gas system. Our first illustration shows a main view of the big shop. The lighting was not a very easy problem owing to the fact that the ceilings are somewhat low, and the lamps at a somewhat lower level than they would have been had a loftier room been available. Nevertheless the measurements show that the general illumination is quite high and, considering the circumstances, fairly evenly distributed. Fig. 1 gives a good idea of the general effect of the lighting. The shop contains a considerable amount of machinery, but is not unduly crowded. At the present time the shops are working overtime owing to Government work

FIG. 3.—Local lighting of lathe with small 100 c.p. units.

and in the foreground on the right hand side will be seen a pile of cylinders for shells in their initiative stages. Some measurements were carried out down the central gangway and values measured on the floor varied from 1.5 up to 3.5 ft. candles, which is probably exceptionally high for gangway lighting.

Our next illustration shows a gangway at the side of the shop which is lighted in a very similar manner, the illumination in this case being 2 to 4 ft. candles. The large units suspended from the roof are stated to furnish approximately 100 candle-power each. In addition local 500 candle-power units equipped with reflectors will be seen from the benches. Measurements on the jaws of several successive vices give results varying from 10 to 12½ ft. candles which is doubtless ample for all ordinary bench work.

Our third illustration shows a view of a lathe which also received light from the small units, in addition to the general illumination. Here again the working illumination was of the order of 10 to 12 ft. candles. It will be noticed that the small units are equipped with anti-vibration devices and we understand that in spite of the severe test to which they are subjected the mantle breakage is not excessive.

THE MONAZITE SANDS OF TRAVANCORE.

At the commencement of the war much amount of interest was aroused amongst gas engineers by the situation regarding the supply of thoria and ceria and other materials for making incandescent mantles. Attention was drawn to the fact that very large deposits of monazite sand, from which these materials may be extracted exist, in Travancore, India.

We observe that, according to the *Gas World*, special arrangements have been made by the India Office for the working of these concessions by the Travancore Minerals Co., in order to ensure that in future, full supplies of these much-needed materials will be available for British industries. Various conditions for the working of the Company are prescribed, including the appointment by the Secretary of State for India of Sir John Hewitt, as Chairman and Director of the Company.

It is added that Messrs. Hopkins and Williams, Ltd., London, have already been granted, by the Travancore Government, a lease for twenty years of 150 acres of monazite sand ground. A scientific staff has been organised, and it is hoped that operations will be begun in October next.

FIG. 1—A general view of large workshop of Messrs. Penrose & Co., lighted by Tilley high-pressure gas lamps.

FIG. 2.—A gangway in the same works lighted by Tilley high-pressure gas lamps. Smaller 100 c.p. units are used to light the benches.

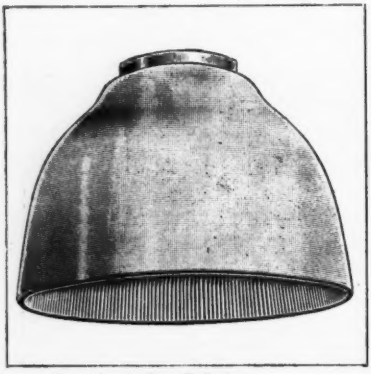
HOLOPHANE INDUSTRIAL LIGHTING.

An opportune booklet issued by Holophane, Ltd., deals with the new Holophane reflectors for industrial lighting. These reflectors are doubtless known to readers of The Illuminating Engineer. The essential novelty in their construction is that aluminium cases are spun over the external prisms so as to seal up the reflector completely and prevent any possible accumulation of dust. Being quite smooth internally and externally, the reflector is easily cleaned, and yet all the advantages of the prismatic construction are gained.

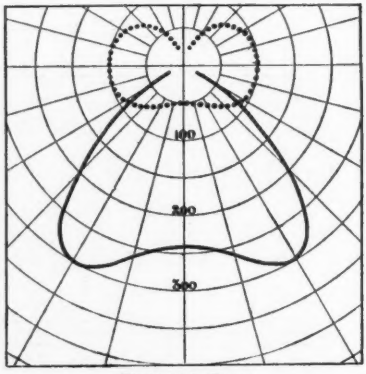
The booklet emphasises the chief essentials of good industrial lighting, namely, *the provision of sufficient illumination, the screening of the light sources from the eyes of operators*, and *the prevention of troublesome shadows*. These requirements are met by the correct shaping and spacing of the reflectors, and detailed tables are given showing exactly what illumination can be secured by spacing the reflectors according to the prescribed rules. On the opposite page we reproduce a complete page relating to the intensive type, which furnishes the lighting engineer with all the data required in order to predetermine the illumination and secure evenness of distribution. We would like to draw particular attention to the table, showing the height at which reflectors must be suspended in order to obtain a certain illumination. In this case the scale of illumination is arranged in graded values separated at convenient intervals, from 0·5 up to 10 foot-candles, the corresponding heights for the reflectors being given to the nearest ¼ foot.

Opposite these data the general appearance and distribution of light from the single unit are shown, thus enabling the illumination under the lamp with local lighting to be also readily calculated.

The booklet contains a table of illumination values for various classes of work. We notice that a distinction is drawn between the illumination required for specific processes and the illumination requisite in the interests of general convenience and safety, for which 0·5—1·0 foot-candles is suggested.



Intensive (I) Type Reflectors.



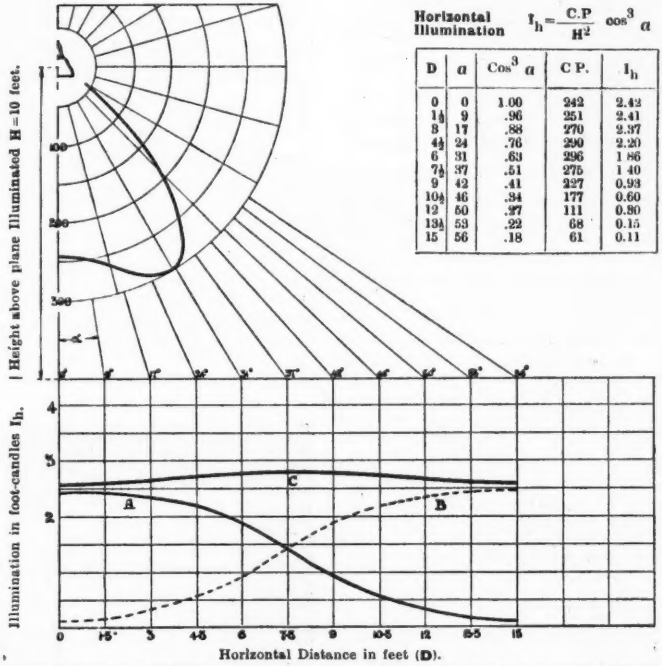
Photometric Curve.
- - - - Lamp alone —— Lamp with Reflector.

Particulars of Holophane "Intensive" Reflectors for Industrial Lighting.

GAS LAMP LOWERING GEAR.

We notice that the **London Electric Firm,** of Croydon, are making a patent lowering gear suitable for use with gas lamps suspended high up in churches and similar large interiors. The lamps can be lowered by winch, the essential part of the apparatus being the special gas-joint which does away with all flexible tubing and is free from troublesome complications. The device provides for two supplies so that a bye-pass can be used. As the joint is capable of withstanding pressure considerably in excess of those habitually used in gas lighting the arrangement should be quite a safe one.

Engineering Data
for
Holophane "Intensive" Type Reflectors.



Horizontal Illumination $I_h = \frac{C.P}{H^2} \cos^3 a$

D	a	$\cos^3 a$	C P.	I_h
0	0	1.00	242	2.42
1½	9	.96	251	2.41
3	17	.88	270	2.37
4½	24	.76	290	2.20
6	31	.63	296	1.86
7½	37	.51	275	1.40
9	42	.41	227	0.93
10½	46	.34	177	0.60
12	50	.27	111	0.30
13½	53	.22	68	0.15
15	56	.18	61	0.11

Curves A or B show the distribution of light from the respective units placed at a height of 10 feet.
Curve C shows the sum of these two units placed at 15 feet apart.
The above data is calculated for lamps rated at 100 c p. To obtain values for other lamps use formula:–

$$\left(\frac{\text{C.P. of Lamp}}{100}\right) \times \text{reading}$$

The following table shows at a glance the candle power of the lamp it is necessary to use and the height at which units have to be placed to get any desired foot candle intensity.

Rated Candle Power of lamp.	Horizontal Illumination in Foot-Candles.														HEIGHT OF UNIT above working plane (feet).
	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	
100	23	16½	13½	11¾	10½	9½	8¾	8¼	7¾	7¼	6¾	6¼	5¾	5½	5¼	
200	—	23	19	16½	14¾	13½	12½	11¾	11	10¼	9½	8¾	8¼	7¾	7¼	
300	—	—	23	20	18	16½	15¼	14¼	13½	12¾	11¼	10¾	10	9½	9	
400	—	—	—	23	21	19	17½	16½	15½	14¾	13½	12½	11½	11	10½	
600	—	—	—	—	25½	23	21½	20	19	18	16½	15¼	14¼	13½	12¾	
1000	—	—	—	—	—	30	28	26	24½	23	21½	19¾	18½	17¼	16½	
1500	—	—	—	—	—	—	34	32	30	28½	26	24	22½	21¼	20	
2000	—	—	—	—	—	—	—	37	35	33	30	28	26	24½	23	

These heights are obtained by the correct spacing of two units (*see graph at top of page.*)

RATIO. 1½ : 1 = Distance apart to height.

A NEW TYPE OF ILLUMINATED SIGN.

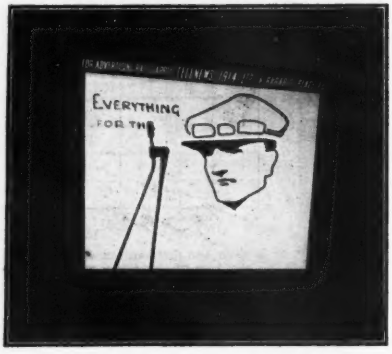
An interesting form of sign has recently been installed at Victoria Station and elsewhere in London, and has attracted a considerable amount of attention during the last few months.

The essential principle of the sign involves a combination of the "Telewriter" device, by means of which any pattern or drawing can be electrically or mechanically reproduced at a distance, with an appliance for projecting this pattern on a screen. The white screen is erected on the platform near the roof on the east side of the Victoria L.B. & S.C. Ry. Station and in this prominent position can be seen by passengers waiting for the trains, from any part of the main platform. The operator sits in a small enclosure a short distance away from the screen. Any desired picture is traced out on a brass plate by a small metal pencil, which is attached to two wires guiding an inking pen operating on a sheet of transparent gelatine paper. When the point of the pencil is applied to the brass plate an electric circuit is completed and the inking pen is thus brought in contact with the transparent paper. Then, owing to the mechanical connection between the pen and pencil, any motion of the latter is reproduced exactly by the former. The drawing is thus traced out in ink on the transparent paper, which is situated in an arclight projector and is thereby thrown on the screen, forming an image of jet black lines on a brilliant white background.

The operator, while sketching out the drawing keeps his eyes on the screen, and the public sees the whole design being sketched out by the pen starting with a blank white sheet and ending with the finished drawing. After the drawing is completed a short time is allowed for it to be seen by the public, and then a new portion of the endless roll of transparent paper is substituted and the process begins over again.

In this way a large number of advertisements can be shown in the course of the evening, a small weekly charge being made for each advertisement thus shown.

The illustrations are reproduced direct from photographs taken entirely by the artificial light at night in Victoria Station. In the small block a view is shown of picture taken from near the projector. The other photograph was taken from the main platform below, the exposure being selected with a view to showing. the sign and also something of the surroundings of the Station. Naturally it is a difficult matter to obtain a photograph to fulfil these exceptional conditions, and the results may be considered satisfactory in view of the difficulty of the problem.

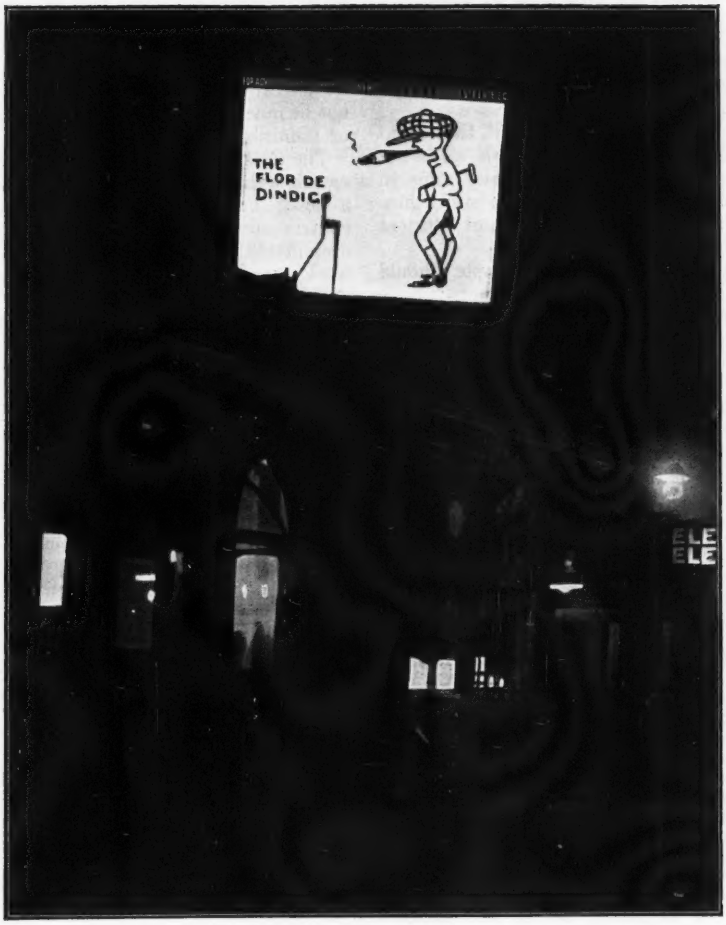


Lumina Bureau Photo.

FIG. 1.—View of the sign at close quarters.

We understand that other installations of this sign will be made in London shortly; it has already been tried for recruiting purposes in Liverpool—and proved almost too successful, attracting a crowd within a few minutes which completely blocked the roadway.

We are indebted for the above account of the working of this apparatus to Mr. Ingle, the General Manager, of Telenews, Ltd., 6, Broad Street Place, London, E.C.



Lumina Bureau Photo.

FIG. 2.—General view, showing the position of the sign as viewed from the platform.

G.E.C. FITTINGS ACCESSORIES.

The General Electric Co., Ltd., have issued their list of "Electric Light Fittings Accessories, 1915" (14th edition). All the usual types of special glassware are illustrated—Superlux, Holophane, Equiluxo, etc., and there is also a special list of cardboard, fancy silk, and fancy glass shades. We note also the new County lantern, with its specially designed Holophane glassware for use with Osram Atmos (half-watt) lamps. The series of reflectors for shopwindow lighting should be of special utility at the present moment when concealed methods are practically unavoidable; there are also listed luminous signs which are stated to conform with the present lighting regulations.

ECONOMY IN THE USE OF LIGHT.

In the present circumstances, when economy is a national duty, people are being advised to be sparing in the use of light.

We of course fully agree that light should be judiciously used and not wasted, and one of the chief aims of illuminating engineering is to study how it can be applied to the most efficient manner.

On the other hand, people should certainly recognise that illumination is a necessity and not a luxury. It must be wisely utilised, but it cannot be dispensed with. Light is *a tool*, and it is false economy to grudge the expenditure of good illumination which the carrying out of efficient work demands.

This is pointed out in a note in a recent issue of the *Gas World*, in referring to some remarks by the Rev. J. C. Pringle, Secretary of the Charity Organisation Society. He observes that "the houses of generals in the Napoleonic wars had one candle after dark; we think one 16-candle-power lamp insufficient (? sufficient) for one room. If all artificial lighting were reduced to the real minimum there would not be much shortage of coal for the fleets or munition factories."

The *Gas World* very properly points out that the wax candle of that time was a most insufficient and unsatisfactory contrivance in comparison with modern illuminants, and that, in the present days, work is carried on at night to an extent undreamed of in the Napoleonic era. The determination of the minimum illumination required for certain processes is a matter for the expert, and cannot be casually decided by reference to past history. Certainly if artificial lighting were reduced to the order of illumination availing in the Napoleonic period, not only our offices but our factories—including those working on munitions—would find it almost impossible to carry on their work.

INTERNATIONAL GAS CONGRESS, SAN FRANCISCO.

READERS will be interested to note the coming International Gas Congress to be held at San Francisco in the week commencing September 27th.

The programme has not yet been definitely completed, but we note that among the proposed papers there will be several dealing with lighting. For example, there is to be a series of contributions on the following subjects:—

Street Lighting, by G. S. Barrows (Philadelphia).

Office and Street Lighting, by Messrs. Fog and Schofield (New York).

Semi-public Lighting, by T. J. Little (Philadelphia).

Buoy and Car Lighting, by G. E. Hulse (New York).

Industrial Lighting (name of author to be announced).

In addition there will be papers by Mr. W. D. Ryan, describing the lighting of the Exhibition, and Dr. Rosa on "The substitution of the heating value for the illuminating value in gas testing."

Of special interest is the announcement of a paper (subject not given) by Dr. Charles Carpenter of the South Metropolitan Gas Co.

INDEX, September, 1915.

A COMPACT TYPE OF PORTABLE ACETYLENE LAMP.

The illustration shows a new type of strong and portable acetylene lamp which has recently been brought out by the Thorn & Hoddle Acetylene Co. (London, S.W.). The model shown above has two jets with appropriate metal shades and can be obtained in two sizes using respectively one lb. and two lbs. of carbide. The two-burner lamp will furnish light for about eight hours before being replenished. Smaller lamps having only a single burner are also available.

The "Incanto" self-contained Acetylene Lamp (Pattern H).

We have recently had the opportunity of inspecting these lamps. Their chief characteristic is simplicity and the strength of the parts. There is no manipulation and really nothing has to be done except to insert the requisite charge of carbide and to fill up with water, ordinary lump carbide being used. The charge is placed in the interior portion of the lamp which fits into the outer can containing the water. There is no tap and the burner is always full on, the consumption of gas being exactly compensated for by the inflow of water through a special valve. Once the lamp is set going it requires no further attention; if the light is no longer required all that is necessary is to raise the interior part of the lamp slightly and the evolution of gas ceases.

These lamps are considered particularly useful for emergency lighting by contractors and builders. They can be carried by hand in dark passages, stood up beside work or hung up on the wall or from the ceiling. Their strength and simplicity has, we understand, led to their being widely used for camps and military work.

The Illuminating Engineering Society.

(FOUNDED IN LONDON, 1909.)

NOTICE OF FIRST MEETING OF THE SESSION.

The First Meeting of the Session will take place at the House of the Royal Society of Arts (18, John Street, Adelphi, London), at **8 p.m.**, on **Tuesday, November 23rd**, when a Discussion on ***The First Report of the Departmental Committee on Lighting in Factories and Workshops*** will be opened by ***Mr. Leon Gaster.***